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THE

WIRELESS ENGINEER

AND

EXPERIMENTAL WIRELESS

VOL. XI. MARCH, 1934. No. 126

Editorial

The Effect of Screening Cans on the Effective Inductance and Resistance of Coils

ON comparing a modern radio receiver with a high-class receiver of a few years ago, the most obvious difference to a casual observer is that, whereas in the older set all the coils were exposed, in its modern counterpart they are enclosed in metal cans with the object of screening them and thus preventing any mutual interaction between them. Such interaction could be electrostatic or electromagnetic. Electrostatic interference could be prevented by a screen possessing only longitudinal continuity, but magnetic interference can only be prevented by a screen which is continuous in the direction in which eddy-currents tend to flow due to the field of the coil. Hence electric screening requires longitudinal or axial continuity and magnetic screening circular continuity; a metal can provides both.

Except in a few special cases eddy-currents do not lend themselves to simple mathematical treatment, and the magnetic screening depends upon the action of eddy-currents set up in the screen. Although the calculation of the effect of an actual screening can on the characteristics of an actual coil would be a very formidable if not an insoluble problem, it can be brought within the range of standard mathematical treatment—though still involving Hankel Functions—by idealising the problem. This has been done by H. Kaden,* of Siemens and Halske, who replaces the cylindrical screen by a spherical one and the cylindrical coil by a dipole of the same magnetic moment placed at the centre of the sphere. Kaden had shown in a previous paper† that the screening effect depends upon the frequency, the material constants and thickness of the screen, and on a single dimension representing the size of the screening can. The exact shape was shown to be of minor importance, so that a very close approximation is obtained by assuming a spherical screen with a diameter equal to the geometric mean of the three co-ordinate dimensions of the cylindrical can.

For those to whom the dipole sounds somewhat unfamiliar we would explain that it is simply a very small solenoid assumed to carry such a current that the field at a distance is the same as that of the actual coil.

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* *E.N.T.*, July, 1933, p. 277.

† *ZS für Hochfreq*, 40, pp. 92–97, 1932.

The dimensions of the coil and screen are usually small compared with the wavelength, so that the wave nature of the field may be neglected and the field assumed to be of the ordinary quasi-stationary type. The field of a cylindrical coil at some distance from the coil is identical with that of a magnetic dipole of the same moment and frequency, and although this may not be strictly true at such a small distance as the radius of the spherical screen, it will be a close approximation.

Screening Efficiency

We do not propose to go into the mathematical procedure; it consists in establishing the Maxwell equations for the three regions, viz.: the inner space, the walls of the sphere, and the external space, and determining the integration constants from the boundary conditions. We shall take all this for granted and consider the results at which the author arrives.

The first result is that, although the field outside the screen is reduced in amplitude and altered in phase by the presence of the screen, it is unchanged in shape, so that a single constant S suffices to specify the ratio in which the amplitude of the field of the coil is reduced at every point outside the screen. This constant is found to be identically the same as that for the reduction of field inside the same screen when situated in an external homogeneous field. If two neighbouring coils are placed in similar screens, the total decoupling factor due to the two screens is thus equal to the square of the constant S.

Reduction of Inductance

The effective inductance of a coil is reduced due to the eddy-currents in the screen which produce a magnetic field which is superimposed upon that of the coil. It is shown that this eddy-current field is uniform and, of course, parallel to the axis of the coil; it is, however, not in exact phase opposition to the field of the coil. The effective inductance of the coil is reduced from L_0 to L where

$$L = L_0\left(1 - \frac{2}{3}\frac{V_c}{V_s}\frac{\alpha}{K}\right) \quad \cdots \quad \cdots \quad \text{I}$$

V_c is the volume of the coil, *i.e.*, the product of its cross-section A and length l; V_s is the volume of the spherical screen, which is always a little less than that of the actual can; K is the constant, always less than 1, by which the inductance of the coil, as calculated from the formula for very long solenoids, has to be multiplied to obtain the actual inductance L_0. For a coil of length equal to its diameter, $K = 0.7$. α is a numerical factor which depends upon the frequency, and the dimensions, permeability and resistivity of the screen. For non-magnetic materials, of which screens are usually made, α is nearly 1 and approximates more closely to 1, the more perfect the screening, *i.e.*, the smaller S becomes. Hence if $\mu = \mu_0$ and $S << 1$,

$$L = L_0\left(1 - \frac{2}{3}\frac{V_c}{V_s}\cdot\frac{1}{K}\right). \quad \cdots \quad \cdots \quad \text{II}$$

—a very simple formula. Hence the effect of the screen on the inductance is inversely proportional to the cube of its diameter.

Increase of Resistance

If skin-effect is negligible so that the eddy-currents are uniformly distributed throughout the thickness of the screen, the effective addition to the resistance of the coil is given by the formula

$$R_s = \frac{3}{2\pi}\,.\,T^2A^2\,.\,\frac{\rho}{tr^4} \quad \cdots \quad \cdots \quad \text{III}$$

where A is the area of cross-section of the coil and T the number of turns, t and r the thickness and radius of the spherical screen, and ρ the resistivity of the material of which it is made. It is also assumed that the material is non-magnetic and that $S << 1$.

If skin-effect causes an unequal distribution of current in the thickness of the screen

$$R_s = 0.95\,.\,10^{-4}\,T^2A^2\,\frac{\sqrt{f\rho}}{r^4} \quad \cdots \quad \text{IV}$$

In either case the additional resistance is inversely proportional to the fourth power of the radius of the screen. In the first case it is inversely as the thickness and independent of frequency, whereas in the second it is proportional to the root of the frequency but independent of the thickness.

Skin-effect in the Screen

Whether skin-effect is negligible or not is easily determined from the value of $t\sqrt{f/\rho}$. If this is less than 5,000 skin-effect is negligible and formula III should be used; if it is greater than 5,000, skin-effect cannot be neglected and formula IV must be employed. If it is about 5,000 either formula can be used; they will give an approximate result.

If the screen is made of iron the conditions are far more complicated. At low frequencies the increase of inductance due to the iron in the field may more than compensate for its reduction due to the eddy-currents.

When unscreened the loss-angle of the coil is given by the formula $\tan\phi_1 = R_0/\omega L_0$; when screened the formula becomes

$$\tan\phi_2 = \frac{R_0 + R_s}{\omega L_0\left(1 - \frac{2}{3}\frac{V_c}{V_s}\cdot\frac{1}{K}\right)}$$

The ratio S in which the external field is reduced by screening can be calculated by a formula which looks rather complicated, even in the case of a non-magnetic screening material, but which enables the result to be obtained in a few minutes. The formula is as follows:

$$\frac{1}{S^2} = \left(\frac{pr}{3t}\right)^2(\cosh 2p - \cos 2p) + \left(\frac{pr}{3t}\right)(\sinh 2p - \sin 2p) + \frac{1}{2}(\cosh 2p + \cos 2p)$$

where r and t are the radius and thickness of the screen and

$$p = \frac{2}{10^4}t\sqrt{\frac{f}{\rho}}$$

An Actual Example

Having calculated p, the various terms can be obtained from mathematical tables. As an example consider a cylindrical screen actually tested by Kaden; it was made of manganin 0.5 mm. thick ($\rho = 42 \times 10^{-6}$ ohms per cm. cube), its radius was 4 cm. and height ~~15~~ cm. The frequency f was 150,000.

9.5cm

$$p = \frac{2}{10^4}0.05\sqrt{\frac{150,000}{42\,.\,10^{-6}}} = 0.6$$

$$\frac{pr}{3t} = \frac{0.6\,.\,4}{3\,.\,0.05} = 16$$

From tables we find that

$$\sinh 1.2 = 1.51;\quad \cosh 1.2 = 1.81;$$
$$\sin 1.2 = 0.933 \quad \cos 1.2 = 0.36$$

On working out the formula it is found that the second and third terms are practically negligible compared with the first, so that for all practical purposes especially in view of the assumptions already made it is sufficient to use the formula

$$\frac{1}{S} = \left(\frac{pr}{3t}\right)\sqrt{\cosh 2p - \cos 2p}$$

In the present example this gives $\frac{1}{S} = 19.3$, whereas the accurate formula gives 19.55.

We can therefore say that such a screen reduces the external magnetic field to about a twentieth of its unscreened value. No clue is given as to the reason for the choice of manganin as a screen material.

A coil 3.5 cm. diameter and 3.5 cm. long, and for which, therefore, $K = 0.7$, was placed in the screening can and tested at the same frequency of 150,000.

Volume of the coil $= V_c = 34$ cm³.

Volume of sphere of 4 cm. radius $= V_s = 270$ cm³.

$$\therefore\ L/L_0 = 1 - \frac{2}{3}\cdot\frac{34}{270}\cdot\frac{1}{0.7} = 0.88$$

The measured value was 0.87.

$t\sqrt{f}/\rho = 3,000$ (Note, this is always 5,000 p)

As this is considerably less than 5,000, the skin-effect is negligible and formula III can be employed.

Taking $\tan\phi = \frac{R_s}{\omega L}$ as a measure of the effect of the screen on the loss-angle, we have

$$\tan\phi = \frac{10^9}{2\pi}\cdot\frac{V_c}{V_s}\cdot\frac{L_0}{L}\cdot\frac{1}{K}\cdot\frac{\rho}{\omega t r}$$

and, if we substitute the above values, this gives 7.10^{-3} against a measured value of $6.3\,.\,10^{-3}$.

In future one need not depend on trial and error in the screening of high-frequency coils; all the essential characteristics can be readily calculated by these relatively simple formulae.

G. W. O. H.

A Diode for Ultra H.F. Oscillations*

A Short Description of a Diode Suitable for the Production of Ultra-High Frequency Electronic Oscillations

By J. S. McPetrie, B.Sc., A.M.I.E.E.

(The National Physical Laboratory)

SUMMARY.—A description is given of a diode suitable for the production of electronic oscillations without the necessity of an external magnetic field as in the case of the magnetron. The electrodes in this valve are cylindrical and the anode lies along the axis of the external cathode. A simple hypothesis is given for the action taking place in such a valve when giving rise to electronic oscillations. As compared with the triode and the magnetron, this valve appears to have advantages in respect of the simplicity of the necessary circuit arrangement and the stability of the frequency of the oscillations produced.

1. Methods of Production of Electronic Oscillations

OSCILLATIONS of very high frequency can be produced by means of a three-electrode valve when the grid is maintained at a high positive potential and the anode at a small negative potential with respect to the filament. The simplest explanation for the occurrence of these electronic oscillations is that a certain number of electrons within the valve are given a to-and-fro motion about the grid, and that this motion may be made to give rise to oscillations the period of which is equal to that of the individual electrons vibrating about the grid.

Much experimental and analytical work has been done on the study of these electronic oscillations.†

The simple hypothesis outlined above has been found to give, approximately at least, the frequency of the oscillations obtained, but it cannot explain why a condition of negative resistance occurs in the valve, nor can it explain the empirical observation that the oscillations occur in any particular case only under a limited range of operating conditions. Until a hypothesis is available by which these factors can be explained satisfactorily it is difficult to decide whether or not a specific design of valve should be suitable for the production of electronic oscillations.

Another method of obtaining electronic oscillations is available. In this method a diode is used with an external magnetic field whose direction lies along the axis of the filament of the diode. A high positive potential is applied to the anode and the intensity of the magnetic field is adjusted so that the electrons emitted from the filament just fail to reach the anode. Under this critical condition strong electronic oscillations occur, the period of which is approximately equal to that of the motion of the individual electrons within the diode. As in the case of the triode, the oscillations occur only if certain other operating conditions (for example, filament current) are adjusted suitably. The efficiency of the magnetron, as this diode with external magnetic field is called, is found to be greatly increased if the anode is split longitudinally and the two halves are connected to a Lecher wire system.

2. Description of Diode Suitable for the Production of Electronic Oscillations

As pointed out above, in both the triode and the magnetron the electronic oscillations appear to be due to the to-and-fro motion of the electrons within the valve. In one case this motion is obtained by a positively charged grid which captures many of the electrons before they have completed any vibratory motion, and in the other case by

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* MS. accepted by the Editor, July, 1933.

† A good critical résumé of work on electronic oscillations is given by Megaw, *Journ. I.E.E.*, 1933, Vol. 72, p. 313.

an external magnetic field the maintenance of which constitutes a limit to the available overall efficiency of the system. The diode described below can be made to give an oscillatory motion to the electrons within it without the necessity of either a grid or an external magnetic field. For this reason it may be found to be more convenient, and possibly more efficient, than either the triode or the magnetron for the production of electronic oscillations. Sahánek* has recently described a valve of somewhat similar design. He explains its behaviour by stating that electronic oscillations can occur in a valve when the anode current varies synchronously with the anode potential. An alternative hypothesis is put forward in the following paper.

The valve described below is simply a cylindrical-electrode diode in which the anode is arranged along the axis of an external cathode. Now in a cylindrical-electrode diode the electric field due to any difference of potential between the electrodes is concentrated near the central electrode. This means that in the case of the diode with internal filament the electrons have a large acceleration near the filament. This large acceleration tends to nullify the effect of the velocity of emission of the electrons from the filament and they travel radially towards the anode. When the filament is external to the anode, however, the velocity of emission becomes an important factor. Any component of the velocity of emission not in a radial direction gives the electron an angular momentum about the anode which remains constant as the electron approaches the anode. As the radial distance from the anode decreases, therefore, so the transverse velocity of the electron increases, and if the anode radius is sufficiently small the electron may escape capture by the anode. Owing to the weak field at the external filament the direction of emission of the electrons is more or less indiscriminate, so that by a suitable choice of electrode dimensions in such a valve a large proportion of the electrons should execute a to-and-fro motion about the anode. As pointed out above, this condition appears to be that required for the production of electronic oscillations.

The use of a diode with external cathode for the production of electronic oscillations was first suggested by the author as early as June, 1932, but circumstances prevented the construction of such a valve until recently, when one was made by H.M. Signal School, Portsmouth. In this valve the anode consisted of a tungsten rod 1 mm. in diameter, around which as axis four tungsten filaments were arranged in parallel on a ring 12.5 mm. in diameter. Calculation shows that with the anode potentials found necessary in this valve for the production of oscillations only a very small number of electrons would escape capture by the anode on their first transit across the valve. Oscillations, however, were easily obtained as described below.

3. Experiments with the Inverted Diode

(a) *General.*

The valve was connected to the circuit shown in Fig. 1. *A* and *B* are two long parallel copper wires 2 cms. apart forming a Lecher wire system between the anode and filament of the valve. *C* is a small variable condenser having a maximum capacity of about 10 $\mu\mu$F. *D* is a circular copper disc 30 cms. in diameter through which the wires *A* and *B* pass. The disc acts as an efficient short-circuit across the Lecher wire system and prevents any standing waves beyond the disc. This being the case, no choke was re-

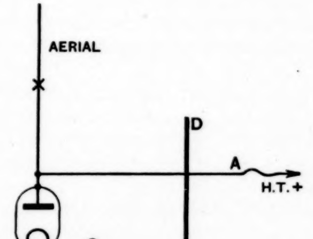

Fig. 1.

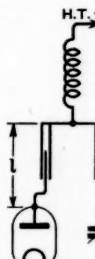

Fig. 2.

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* Sahánek, *Phys. Zeits.*, Vol. 33, 1932, pp. 693–703.

quired in the wire *A* which formed the anode supply lead. Chokes were inserted in the filament leads as shown in the diagram. The output was measured by means of a 25 mA. non-contact thermo-junction inserted at the centre of the aerial, which was approximately 50 cms. in length and connected directly to the anode.

With an anode potential in the region of 360 volts oscillations were obtained at a wavelength of about 1.5 metres. Reception on an oscillating receiver of the retroactive type showed that the oscillations were confined in frequency to a narrow band and that the frequency was remarkably constant for such an oscillator. It was also observed that the frequency of the oscillations could be controlled over a fairly wide range (see next section) either by moving the disc *D* along the wires *AB* or by altering the capacity of the condenser *C*. As the disc *D* was made to approach the valve so the frequency of the oscillations increased, but there was a lower limit to the distance of *D* from the valve. If the disc was placed nearer the valve than this the oscillations ceased and could only be restarted by moving *D* away from the valve and then gradually bringing it back again.

The aerial did not act as an efficient radiator, as was shown by the fact that the received signal did not diminish very much in intensity when the aerial was removed. It was observed also that the received heterodyne note was purer when no aerial was used at the transmitter. The reasons for these empirical results were not investigated as the problem under immediate consideration was the determination of the main features in the production of electronic oscillations by means of the "inverted diode."

(b) *Dependence of Wavelength on External Circuit.*

As described above, the wavelength of the oscillations appeared to be dependent on the constants of the external circuit. An experiment was made, therefore, in which these constants could be varied by means of altering the circuit length while all other operating conditions of the valve remained constant. As can be seen from Fig. 2, the circuit consisted of two telescopic systems of wiring inserted between the anode and filament respectively of the valve and the terminals of a small variable condenser. The lengths of these two telescopic systems and the capacity of the condenser having been adjusted suitably for strong oscillations, the length "*l*" of the system attached to the anode was altered while the other circuit arrangements remained fixed. It will be seen from Table I that the wavelength of the oscillations is intimately bound up with the length of the circuit attached to the anode.

TABLE I.

Length Circuit Attached to Anode *l*.	Wavelength.	Anode Potential.
8 cms.	94 cms.	600 volts
10 ,,	102 ,,	,, ,,
12 ,,	106 ,,	,, ,,
15 ,,	118 ,,	,, ,,

The wavelength was determined by means of the harmonics of an ordinary retroactive oscillating detector, and, sufficient radiation being obtainable from the electronic oscillator without the necessity of an aerial, none was used, as it complicated the construction and ease of variation of the external circuit.

(c) *Dependence of Wavelength on Anode Potential.*

With the same circuit arrangement as shown in Fig. 2, another experiment was made in which the external circuit was kept constant while the anode potential was altered from 360 to 540 volts. The wavelength of the oscillations was sensibly constant at 142 cms. over this wide range. The output, however, varied according to the anode voltage. To a first approximation the wavelength was independent of filament emission.

(d) *Space-charge Conditions for Maximum Oscillation Intensity.*

An experiment was made in which the current in a tuned Lecher wire system coupled to the oscillator was observed as the filament current in the valve was altered while the other operating conditions of the valve remained fixed. The results obtained in this experiment are shown graphically in Fig. 3. In this Fig. the solid-line curve gives the relation between anode and filament currents while the dotted line curve shows how the current in the Lecher wire system varied with filament current. It will be observed that maximum oscillation intensity is obtained at about the lower end of the straight portion of the anode current-filament current characteristic and, therefore, well before the condition of current limitation by space charge.

(e) *Relation Between Period of the Oscillations and Electronic Time of Travel.*

As pointed out above, there is a wide possible range of frequency of the oscillations for any given anode potential. Maximum output occurs, however, for any anode potential at a fairly definite wavelength. Calculation showed that the period corresponding to this wavelength was in any particular case approximately three times the time of transit of an electron from the filament to the vicinity of the anode. This result suggested to the author that the electrons responsible for the oscillations might be those whose emission velocity was in the direction away from the anode. In order to test this idea a large negative potential was applied to a piece of copper gauze wound round the glass of the valve. It was assumed that if the above reason were correct the application of this negative potential in limiting the displacement of the electrons in the outward direction would alter the output. No effect, however, was observed. The same result was obtained when copper gauze was made positive with respect to the filament. The reason for the unexpectedly long wavelength may be that the cathode consisting of four filaments did not act as a true cylindrical electrode.

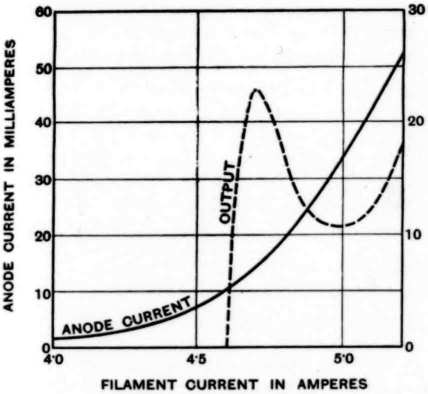

Fig. 3.

(f) *Effect of a Magnetic Field Along Direction of Electrode-Axis.*

It was considered that if the oscillations are obtained because a certain number of electrons escape capture by the anode, then increased output might result when a magnetic field was applied along the direction of the anode. It was found, however, that this application of such a field decreased the output.

The work described in this paper was carried out as part of the programme of the Radio Research Board, and is published by permission of the Department of Scientific and Industrial Research.

The New Budapest Half-wave Mast-aerial

THE new 120 kilowatt Hungarian broadcasting station at Lakihegy, near Budapest, which has recently been put into service, uses the mast itself as the aerial. Like that at the Bisamberg-Vienna station, which we described in our October number, the mast is in the form of two pyramids placed base to base. The height is 284 metres and the mast constitutes a half-wave aerial, the wavelength being 550.5 metres. Accurate tuning is carried out by means of an adjustable extension at the top of the mast, in the form of a pole 30 metres long which can be raised and lowered; the maximum height is thus 314 metres or 1,030 feet.

Book Review

Tables of Functions

By Jahnke and Emde. xviii + 330 pp. 171 Figs. Teubner. 16 Marks.

The first edition of these mathematical tables has been out of print for some time. This new edition has been almost completely rewritten. It is something entirely new in mathematical tables, for it not only contains the numerical tables, but also a large number of curves and diagrams showing the various functions in relief. As Prof. Emde says in the preface, "in this method which is adopted here for the first time, the function reveals itself in its entirety; whereas formerly one had to link up in his mind the separate and disconnected characteristics and peculiarities of a function, one can now see the whole range at a glance."

The whole range of mathematical functions is covered from simple reciprocals and square roots to Riemann's Zeta function.

Everything in the book is given in both German and English, and at the end of each section there is an excellent bibliography giving references to text-books and other more specialised tables.

This book sets a new standard in mathematical tables, and it is remarkable that it can be produced for 16 marks. G. W. O. H.

The Problem of Duplex Telegraphy in the Mercantile Marine Wireless Service*

By M. Reed, M.Sc., A.C.G.I., A.M.I.E.E.

1.0. Introduction

THIS article is concerned with the factors which influence the design of a ship's wireless duplex telegraph system to operate on wavelengths of the order of 2,000 metres.

On large liners, the bulk of the wireless messages are transmitted and received in the waveband 1,875 to 2,725 metres, C.W. only being used. It is sometimes found, during periods of heavy wireless traffic, that appreciable delay may be caused because it is possible to receive messages only when the long-wave transmitter is not in operation. To avoid this congestion, it is necessary to provide arrangements for duplex working in the above waveband.

Simultaneous transmission and reception obviously cannot be carried out on the same frequency; but, to ensure that the ship will have available a reasonable number of channels in the given waveband, it is necessary to make the required separation between the two frequencies as small as possible. On the other hand, to avoid excessive complication, it is advisable to arrange for this separation to be sufficient to make the beat frequency at least above audibility. To effect a compromise between the two considerations, it will be assumed in the following that the difference in frequency between the transmitted and received signals is of the order of 10 per cent.

2.0. The Nature of the Problem

Although the fundamental considerations in the design of long-wave duplex telegraph stations on land and on sea are the same, the actual problems are different in that many of the difficulties encountered on a ship do not arise on a land station. The chief differences between them are :—

(1) On a land station the transmitter and the receiver can generally be located at suitable sites a few miles apart. On a ship this separation can rarely exceed a few hundred feet, and in most cases the choice of sites is very limited.

(2) On a land station it is possible to employ directional aerial systems for transmission and for reception. On a ship it is generally practicable to use only simple aerials.

(3) On a land station it is possible to have a high quality transmitter. On a ship the installation of such a transmitter is generally impossible from the point of view of cost, space required and operating personnel.

There is therefore very little of actual land station practice which can be applied to ships.

As on a land station, the problem of duplex working on a ship can be considered under the following heads :—

(*a*) The transmitting and receiving aerials.

(*b*) The receiving apparatus.

(*c*) The transmitting apparatus.

These are investigated in detail below.

3.0. Aerial Arrangements

When working duplex on a land station, it is standard practice to employ separate aerials for transmission and for reception. A number of methods which require only one aerial have been suggested.[1] These, however, all employ a number of circuits which have to be accurately adjusted to the frequencies of the transmitted and received signals. To use them on a ship, where it is necessary to operate over a wide frequency band, would introduce considerable complication. It is therefore advisable to adopt the simpler arrangement which involves the use of two aerials.

Even on the largest liner afloat, it would be impossible to separate the two aerials by a distance exceeding 1,000ft. As a result of this proximity the following factors must be

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* MS. accepted by the Editor June, 1933.

[1] Palmer, "Wireless Principles and Practice," pp. 103–106.

taken into consideration in deciding on satisfactory positions for the aerials :—

(1) The value of the voltage induced in the receiving aerial by the radiation from the transmitter.

(2) The "shadow" effect of the transmitting aerial on the receiving aerial.

For a given arrangement of the aerials, the voltage induced in the receiving aerial can be measured by connecting a hot-wire milli-ammeter in series with the earth and the foot of the aerial. If I amps is the current obtained when the transmitter is giving its normal output, say, at 2,000 metres, then since it can be assumed that this wavelength is much greater than the natural wavelength of the receiving aerial, the voltage set up between the foot of this aerial and earth is given by[1]

$$E = \frac{I}{\omega C}$$

where C = capacity in μF. as measured between the foot of the aerial and earth

$\omega = 2\pi \times$ frequency of transmitter signal.

With a standard type of transmitter, the voltage obtained can be expected to be of the order of 200 volts.

The "shadow" effect of the transmitting aerial on the receiving aerial results in a change in the efficiency of the latter when the two systems are tuned to wavelengths which are close together. On a ship it is generally found that a reduction in efficiency is obtained when the wavelength of the transmitting system is less than that of the receiving system, and an increase is obtained when the transmitting wavelength is greater than the receiving wavelength. This means that, although the "shadow" effect may assist duplex working when the wavelength of the received signals is less than the wavelength of those transmitted, it may make duplex working impossible in the converse case. In practice, it is not always possible to allot the longer wavelength to the transmitted signals ; therefore it is necessary to reduce the "shadow" effect to a minimum so that the number of channels available for duplex working in the given waveband may not be restricted.

If the strength of the signals obtained from a distant transmitting station is noted at the same time as the wavelength of the ship's transmitting aerial system is varied in the neighbourhood of the wavelength of the received signals, a curve of the form shown in Fig. 1 is obtained. The wavelength values given to a number of points on this curve are meant to indicate the type of result to be expected, and do not refer to any particular case.

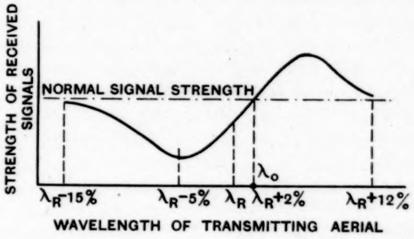

Fig. 1.—λ_R = *wavelength of receiving aerial.*

It is seen that, for wavelengths less than λ_0, a loss in efficiency is obtained when the ship's transmitting aerial is tuned to any one of a range of wavelengths which are in the neighbourhood of the wavelength to which the receiving system is tuned. For a number of wavelengths greater than λ_0, a gain in efficiency is obtained. The efficiency loss is generally a maximum when the wavelength of the transmitter is about 5 per cent. less than that of the receiver. Both the maximum loss in efficiency obtained and the width of the band of wavelength settings for the transmitting aerial which produce a loss in efficiency increase as either or both of the following are increased :—

(1) The magnitude of the mutual impedance between the aerials.

(2) The ratio of the e.m.f.'s induced by the distant station in the ship's transmitting aerial and in the receiving aerial.

For a given receiving aerial, (1) decreases as the aerials are moved further apart and (2) decreases as the size of the transmitting aerial is reduced.[1]

---

[1] Moullin, "On the current induced in a Wireless Telegraph Receiving Antenna," *Proc. Camb. Phil. Soc.*, Vol. 22, p. 569.

[1] A complete analysis of "shadow" effect is given in a paper on "The Spreading of Electromagnetic Waves from a Hertzian Dipole," by Ratcliffe, Vedy and Wilkins in *J.I.E.E.*, May, 1932, p. 530.

To reduce both the voltage induced in the receiving aerial by the ship's transmitter and the "shadow" effect of the transmitting aerial, it is therefore necessary to keep the two aerials as far apart as the structure of the ship will permit. By having separate transmitting and receiving rooms it is obviously possible to obtain a greater separation between the aerials than would be the case if one room were used for both purposes. To obtain maximum separation between the aerials, it is desirable to place these rooms at opposite ends of the ship so that the arrangement shown in Fig. 2 can be adopted. Where the rooms cannot be placed as far apart as this, satisfactory results should be obtained by leading a portion of the receiving aerial into the cabin by means of a lead covered cable in the manner suggested by Fig. 3. In this way the aerials can be kept as far apart as possible, and the cable itself should produce some reduction in the direct coupling between them. Suitable positions for the aerials will therefore be decided by the voltage induced in the receiving aerial and by the "shadow" effect of the transmitting aerial. If one of the above arrangements can be adopted, there should be no difficulty in obtaining satisfactory results.

4.0. Consideration of the Receiving Apparatus

Since the radiation from the ship's transmitter induces a voltage of the order of 200 volts in the receiving aerial, it is necessary to interpose some form of filter between the aerial and the first valve in the receiver itself. As a first step, it is therefore necessary to decide on the design of a suitable form of filter.

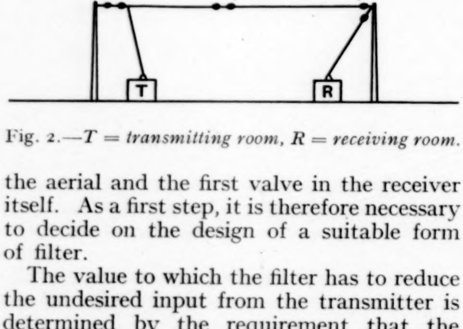

Fig. 2.—T = *transmitting room*, R = *receiving room.*

The value to which the filter has to reduce the undesired input from the transmitter is determined by the requirement that the resulting grid-swing in the first receiving valve must not be sufficient to overload that valve when the receiver is being operated under normal working conditions. The value of permissible grid-swing depends on the type of valve employed, but it can be assumed that its value will be in the neighbourhood of 1 volt.

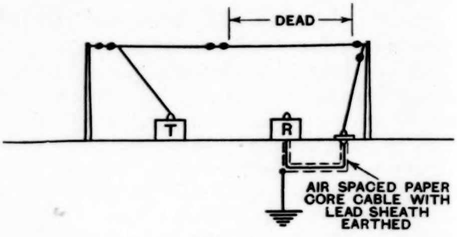

Fig. 3.

It is next necessary to decide on the type of filter to be employed.

4.1. Type of Filter to be Used

At a given frequency, the voltage produced at the input to the first valve by the radiation from the ship's transmitter can be kept below the specified upper limit by introducing a suitable attenuating network between the foot of the receiving aerial and earth. In general, this network can take one of the following forms :—

(*a*) A filter of the low, high or band-pass type comprising components of fixed value.

(*b*) A rejector circuit tuned to the given frequency.

(*c*) An acceptor circuit tuned to a frequency other than the given one.

In practice, however, the same frequencies are used, at different times, for both transmission and reception. It is therefore impossible to specify the cut-off frequency or frequencies of a network of the first type, and the choice must therefore lie between types (*b*) and (*c*).

The disadvantages of a rejector circuit are :—

(1) The operator receiving the signals must know the frequency of the ship's transmission so that he can set the circuit accordingly. With more than one receiver in use simultaneously, this leads to delay ; because a change in the frequency of transmission cannot be made until the rejector

associated with each receiver has been retuned.

(2) For a given setting of the circuit, signals whose frequency differs from the resonance frequency of the circuit are attenuated less than the signals to which the circuit is tuned. Also, the greater the frequency difference, the lower is the attenuation. Harmonics in the transmitter output therefore suffer less attenuation than the fundamental, and it is possible for them to produce more than the specified input to the receiver. This input may be augmented by signals from neighbouring transmitting stations whose frequency differs from the resonance frequency of the rejector circuit.

With an acceptor circuit, however, the above disadvantages do not appear. The circuit is tuned to the frequency of the distant transmitting station in the same way, and at the same time, as the receiver itself. A knowledge of the frequency of the ship's transmitter is therefore unnecessary, so long as it differs by more than 10 per cent. from the frequency of the desired signals. Further, all signals whose frequency differs from the resonance frequency of the circuit suffer greater attenuation than those to which the circuit is tuned. The possibility of interference from harmonics and also other transmitting stations is therefore considerably reduced.

4.2. Requirements of the High-frequency Amplifier

Having decided on the type of filter to be employed, it is next necessary to consider the requirements of the H.F. side of the receiver.

With an installation of the type under consideration, it may be necessary to obtain satisfactory reception with an input to the receiving aerial of the order of 10 μV/metre. This means that the input to the first valve arising from the desired signal will be very much smaller than that produced by the undesired signal from the ship's transmitter, with the result that, unless the H.F. amplifier is sufficiently selective, the undesired signal will give a much higher input to the detector than the desired signal.

Although the frequency of the former differs by more than 10 k.c. from the frequency of the desired signals and should therefore cause no audible interference, yet the grid-swing in the detector arising from the undesired signals will influence the audio frequency output of the receiver in the following way. It is known that, except for small inputs confined to the square law part of the rectification characteristic, when a modulated carrier signal and an interfering unmodulated carrier are both present in the input to a detector, the latter modifies the rectification characteristic for the former, with the result that the audio frequency output of the detector is reduced. In the case under consideration, the desired signal combined with the output from the local oscillator (to give the required beat-note) gives an input which corresponds to the modulated carrier signal, and the undesired signal from the ship's transmitter corresponds to the interfering carrier, therefore the presence of the latter results in a reduction of the audio frequency output. Further, the greater the input to the detector produced by the undesired signal, the greater is the reduction in the audio frequency output.[1]

When the input to the detector resulting from the desired signal is about three times greater than that obtained from the undesired signal, the reduction in audio frequency output can be ignored. It is therefore necessary to design the H.F. amplifier to be sufficiently selective to obtain this ratio.

4.3. Requirements for the Detector and the Low-frequency Part of the Receiver

Since C.W. signals are to be received, it is usual with a receiver of this type to incorporate a separate local oscillator to give the necessary audio beat frequency. The detector employed can be either of the anode bend or of the grid leak type. In the case of the former the sensitivity is lower, but, for a given input from the ship's transmitter, it is possible to obtain a reduction in the demodulation effect discussed above.

To obtain additional selectivity, it is advisable to incorporate a note-filter set to 1,000 cycles (or any other convenient frequency) in the output of the detector. This will provide an additional means of discriminating between the desired beat-note and the beat-notes resulting from heterodyning between undesired signals and the local oscillator, or between these signals and the input from the ship's transmitter.

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[1] Appleton and Boohariwalla, *Wireless Engineer*, Mar., 1932.

The output of the detector can then be coupled to a L.F. amplifier in the usual way.

4.4. Illustrative Example

As an illustration of the foregoing, the design of a filter and receiver to satisfy the following conditions will be considered :—

(*a*) Voltage induced in the receiving aerial by the ship's transmitter : $V_i = 200$ volts.

(*b*) Minimum value of the field strength, as measured at the receiving aerial, for which duplex working is required : $E_0 = 10$ microvolts per metre.

(*c*) Effective height of the receiving aerial : $h = 20$ metres.

(*d*) Maximum value of the input to the first high-frequency amplifying valve which the ship's transmitter should be permitted to produce : $V_g = 0.5$ volts.

(*e*) Amplification factor of the inductances used in the filter and receiver : $m = 100$.

(*f*) Percentage frequency difference between transmitter and receiver signals : $\triangle f = 10$

so that $z = \dfrac{2}{100} \times \triangle f = 0.2$.

Let N_f = amplification value of the filter at resonance.

N_r = value of the high-frequency amplification of the receiver at resonance.

S_f = selectivity value of filter.

$$= \frac{N_f}{\text{amplification when filter is detuned by 10 per cent.}}$$

S_r = selectivity value of the high-frequency amplifier.

The first condition to be satisfied is that the permissible grid-swing arising from the ship's transmitter must not be exceeded.

i.e.
$$\frac{N_f}{S_f} \times V_i < V_g$$

Therefore the minimum value for $\dfrac{S_f}{N_f}$ is given by :—

$$\frac{S_f}{N_f} = \frac{V_i}{V_g} = 400$$

This value can be easily obtained by employing a chain consisting of four resonant circuits.[1] For example, a chain in which the coupling coefficient between the links is equal to $\dfrac{1}{m}$ *i.e.* 0.01 gives a value for N_f of 21.2 and for S_f of 2.32×10^4. The voltage input to the first high-frequency valve produced by the ship's transmitter is therefore given by :—

$$V = V_i \times \frac{21.2}{2.32 \times 10^4} = 0.1835 \text{ volts.}$$

It is next necessary to decide on the number of tuned high-frequency amplifying stages to be used in the receiver. This is determined by the required value for the ratio of the inputs to the detector produced by the desired and undesired signals. To provide for negligible demodulation, a value of 5 can be used as a basis for design.

The input to the detector produced by the desired signal is given by :—

$$V_d = E_0 h N_f N_r \times 10^{-6} \text{ volts}$$

and the input produced by the ship's transmitter is given by :—

$$V_u = V \cdot \frac{N_r}{S_r}$$

Therefore

$$\frac{V_d}{V_u} = 5 = \frac{10 \times 20 \times 21.32 \times S_r \times 10^{-6}}{0.1835}$$

Therefore $S_r = 215.$

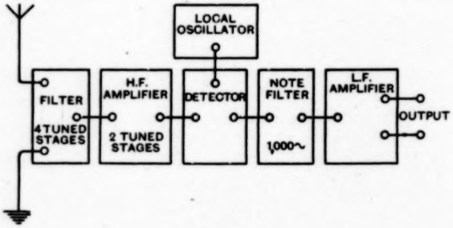

Fig. 4.

The value of S_r for two tuned stages of high-frequency amplification is given by[1]

$$S_r = A(zm)^2 = 400A$$

" *A* " depends on the value of the coupling between the valve and the tuned circuit. In the case of screen-grid valves the coupling must be kept small to ensure stability, and we can put A equal to unity without introducing great error. Therefore two high-frequency stages will be sufficient to satisfy the given conditions.

---

[1] " Analysis and Designs of a Chain of Resonant Circuits," *Wireless Engineer*, June, 1932.

The receiving apparatus will therefore take the form shown diagrammatically in Fig. 4.

5.0. Transmitter Requirements

To avoid the danger of inducing a very high voltage in the receiving aerial, the power of the transmitter and the size of its aerial should be kept as small as possible consistent with obtaining the necessary operating range. Further, the "shadow" effect of the transmitting aerial will be reduced as its size is decreased.

Harmonics in the transmitter output will not effect duplex working because the frequency separation between them and the received signals will be much greater than 10 %.

Satisfactory duplex working will, however, be difficult unless interference from the following can be prevented.

(*a*) Ripple in the power supply to the transmitter.

(*b*) Sparking and other disturbances from electrical machinery and apparatus.

(*c*) Key clicks.

The type of interference obtained from the first two is well known and can be avoided by standard methods. The third type of interference is characterised by the presence in the telephones of a series of loud clicks or thuds which correspond to the makes and breaks at the signalling key of the transmitter. These clicks interfere with reception on practically all wavelengths, but they are most severe in the wavelength band which is about 200 metres on either side of the fundamental.

These clicks are due to the fact that when the transmitter is caused to oscillate or ceases to oscillate a steady condition does not obtain at once, there being a transitional stage in which transient oscillations are produced. These oscillations contain waves of largely varying frequencies which influence adjacent receivers, and, irrespective of the tuning of these receivers, a click is produced in the ear-phones each time the transmitter is keyed. The loudness of the click obtained depends on :—

(*a*) The difference between the tuning of the receiver and the fundamental of the transmitter.

(*b*) The sensitivity of the receiver.

(*c*) The method of keying transmitter.

In cases where the first two conditions are fixed, it is found that interference from key-clicks can be practically eliminated by introducing a delay system in the transmitter keying circuit.

With such an arrangement the transmitter gradually builds up to and falls away from its maximum output each time the signalling key is manipulated, and a sudden surge of large magnitude is avoided.

6.0. Conclusions

To work duplex on a ship with a separation of about 10 per cent. between the wavelengths of the transmitted and received signals, when the transmissions are in the neighbourhood of 2,000 metres, it is necessary to make the following arrangements :—

(1) Erect the transmitting and receiving aerials so that the voltage induced in the latter by the ship's transmitter and also the "shadow" effect produced by the former are not excessive.

(2) Interpose a chain of resonant circuits between the receiving aerial and the first receiving valve sufficiently selective to prevent the overloading of that valve by the ship's transmitter.

(3) Make the high-frequency amplifier sufficiently selective to prevent any demodulating effect by the input to the detector from the ship's transmitter.

(4) Incorporate a note-filter in the output of the detector.

(5) Make the output of the transmitter and the size of its aerial as small as possible.

(6) Avoid interference from key-clicks, ripple in power supply to the transmitter, electrical disturbances from machinery, etc.

To work duplex with a smaller separation than 10 per cent. between the wavelengths

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[1] Runge, *Telefunken Zeitung*, Oct., 1927, p. 54, 55.

of the two transmissions it is necessary to determine :—

(1) Whether a suitable arrangement for the aerials can be found which will

- (*a*) reduce the voltage induced in the receiving aerial by the radiation from the ship's transmitter sufficiently to make inexcessive the number of links required in the filter interposed between the receiving aerial and the receiver itself.
- (*b*) reduce the mutual impedance between the transmitting and receiving aerials sufficiently to make inappreciable the loss in efficiency caused in the latter when the two systems are operated on wavelengths which are less than 10 per cent. apart.

(2) Whether the receiver can be designed to discriminate effectively between the desired and undesired signals when the frequency difference between them is audible. It may be possible to do this by employing either or both of the following :—

- (*a*) A receiver of the super-heterodyne type.
- (*b*) An efficient note-filter in the output of the detector.

Acknowledgment

The author desires to thank Siemens Brothers and Co., Limited, Woolwich, for permission to publish this article.

Correspondence

Letters of technical interest are always welcome. In publishing such communications the Editors do not necessarily endorse any technical or general statements which they may contain.

What is Demodulation?

To the Editor, The Wireless Engineer.

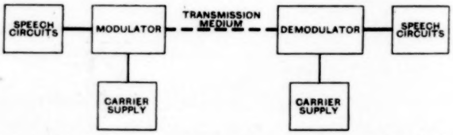
SIR,—Relative to our recent discussion of the use of the word "demodulation," let me offer a pertinent quotation :

> "'When I use a word,' Humpty Dumpty said, 'it means just what I choose it to mean—neither more nor less.'
>
> "'The question is,' said Alice, 'whether you *can* make words mean so many different things.'
>
> "'The question is,' said Humpty Dumpty, 'which is to be master—that's all.'"

Now these remarks reinforce the accepted American usage of "demodulation" in two particulars : first, since the word, coined originally by a group of Bell System engineers, had not previously been used, we must not question their right to give the word whatever meaning they might choose for it ; second, in the sense of "detection," the word supplies a definite need; as an alternative to "reduction in modulation" the word will be seldom used.

Etymology should, therefore, wait on utility, and the word continue in the first meaning.

But further than this, the use of "demodulation" to mean "detection" has perhaps more justification than you have granted to it. We might think of other words with a parallel usage. Take, for example, "decapitate." Here we act on a *man* and produce a *head* and a *trunk*. There is no definite indication as to which portion centres the attention. Similarly, we may *demodulate* a *signal* and produce *carrier* and *speech*. In this sense *demodulation* is the inverse of *modulation*. It is true that *modulation* refers strictly to a process carried out on a carrier wave, but this concept has become greatly weakened by the common usage of the word. That is, the radio and the telephone engineer think particularly of what we might call the *intelligence channel*, the carrier generation is merely an accessory process. This attitude is clearly shown by the fact that in the early carrier-telephone developments the "demodulator panel" included the carrier oscillator. Thus, to the telephone engineer, the whole system appeared somewhat as shown in the figure. Here, clearly, the demodulator performs the inverse process to that carried out by the modulator. That the modulator is linked firmly with the speech circuits is shown by the fact that while the more correct usage is undoubtedly to define the modulator as the carrier-frequency amplifier in which modulation takes place, yet more generally this term is applied to the final stage of the speech amplifier. In the eyes of the engineer, if not in strict fact, detection appears quite clearly as the inverse process to modulation ; this being so, "demodulation" is the logical substitute for "detection."



Even in America, of course, "demodulator" and "demodulation" are not commonly used in popular radio circles, but the latter, particularly, is rapidly coming into more general use. The British meaning of this word is entirely unknown here.

Montreal. C. B. FISHER.

Decoupling Efficiency

To The Editor, The Wireless Engineer.

Sir,—It was with great interest that I read the letter written by Mr. Kinross, entitled "Decoupling Efficiency," in the November issue of the *Wireless Engineer*.

As you pointed out, the phase relations must be considered, because they would probably influence the result to a great extent. They do!

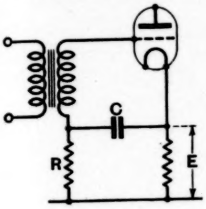


Fig. 1.

Consider the circuit used by Mr. Kinross as an example. Fig. 1, with its vector diagram, Fig. 2. Assuming R and C to be in series across E, then

$$I = \frac{E}{\sqrt{R^2 + \frac{1}{\omega^2 C^2}}}$$

I will be at an angle θ (leading) to V, where $\tan\theta = \frac{1}{\omega CR}$ from the Impedance Triangle, Fig. 3.

$\therefore$ Voltage across condenser $= V$.

$$= \frac{I}{\omega C} = \frac{E}{\omega C\sqrt{R^2 + \frac{1}{\omega^2 C^2}}}.$$

But the component V' of V, which is in phase with E, is the troublesome voltage.

$$V' = V\sin\theta$$

$$= V\frac{1}{\omega C\sqrt{R^2 + \frac{1}{\omega^2 C^2}}} \quad .. \text{ (From Fig. 3).}$$

$$= \frac{E}{\omega^2 C^2\left[R^2 + \frac{1}{\omega^2 C^2}\right]}$$

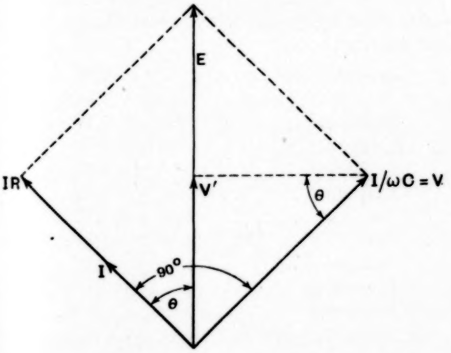


Fig. 2.

It seems logical to express the percentage decoupling efficiency as :—

$$\eta\,\% = \frac{E - V'}{E} \times 100\,\%$$

$$= \left[1 - \frac{1}{1 + \omega^2 C^2 R^2}\right] \times 100\,\%$$

$$= \frac{\omega^2 C^2 R^2}{1 + \omega^2 C^2 R^2} \times 100\,\%$$

If we have $C = 1\ \mu F$.
$R = 10{,}000$ ohms.
and $\omega = 2\pi f = 2\pi \times 50$,

then the efficiency works out at just over 9 per cent. which is sadder still!! To get an efficiency of even 50 per cent. requires that $R = \frac{1}{\omega C}$.

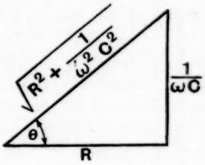


Fig. 3.

If $C = 1\ \mu F$ and $f = \frac{\omega}{2\pi} = 50$ cps. as before,

R (for $\eta = 50\,\%$)
$= 31{,}850$ ohms!

Using the same value of capacity at the same frequency requires that R should for $\eta \times 95\,\%$ be at least 138,800 ohms!!!

So it seems that using small values of R and C is just waste of money and time.

It should be noted that, luckily, the decoupling efficiency increases as the square of R, C and ω.

Cape Town, B. J. Stevens.
South Africa.

The Industry

The new loose-leaf Dubilier list, No. 933 G, is primarily intended for those professionally and commercially engaged in the various branches of wireless engineering. It contains full particulars of the condensers and resistances made by the firm, together with dimensions, etc., and a great deal of useful technical data.

Graphite has obvious attractions for the lubrication (during manufacture or assembly) of the moving parts of wireless apparatus which are unlikely to receive any subsequent attention. The makers of "Oildag"—graphite colloidally dispersed in oil—deal with the radio applications of this preparation in their *Technical Bulletin*, No. 102.5, which has just been issued. Address, E. G. Acheson, Ltd., 40, Wood Street, Westminster, London, S.W.1.

Soft rubber "grommets" or bushings for protecting wires where they pass through metal base-plates, etc., are manufactured in a number of sizes by P. B. Cow and Co., Ltd., Streatham Common, London, S.W.16.

The Ferranti "Circuit Tester," an inexpensive A.C.-D.C. multi-range meter (volts, milliamps., and ohms) is fully described in a leaflet, No. Wa529.

Mercury Arc Power Rectifiers for Wireless Stations*

By K. Kotschubey

(*Brown Boveri & Co.*)

THE intensive development of wireless transmission in recent years and above all the big outputs for which individual transmitting valves can now be made have brought about a corresponding transformation of the converter plants to supply these stations. The general trend of the development of such equipments has been in the course of the recent years to increase the output of the transmitting valves without being obliged to use the same large number of valves in parallel, as was the case in transmitting stations in operation. The technical development of the construction of such valves therefore eventually led to the adoption of high D.C. voltages. Thus transmitting valves are now built for D.C. voltages up to 25,000 volts, while the voltages in common use up to the present have been in the neighbourhood of 12,000–15,000 volts.

The operation of such valves naturally requires corresponding outputs and voltages to be obtained from the converting plants. The experience gained recently in numerous plants working with Brown Boveri mercury arc rectifiers (the special features of which are all embodied in the Peebles-Brown-Boveri type manufactured in this country) proved that for outputs as low as 60 kW. and upwards and at voltages over 10,000 volts, this type of converter is the most economical and the most reliable.

The first rectifier for 400 kW. output at a service voltage of 12,000 volts which was an unusually high one, was put into service in the year 1929 in the workshops of the Marconi's Wireless Telegraph Co., Chelmsford. Since then the unit has been in continuous service, and the experience gained therewith shows that the high voltage mercury arc power rectifier is especially suitable for various transmitting stations. The recent development which has taken place on the European Continent shows that metal clad mercury arc rectifiers have been generally adopted for most of the new broadcasting stations. The Marconi Wireless Co., which equipped the broadcasting stations of Warsaw (Poland), Beromunster (Switzerland), and Athlone (Irish Free State), as well as Monte Ceneri (Switzerland), adopted in all these plants metal clad mercury arc rectifiers, the output of which varies between 60 and 500 kW. At the Warsaw broadcasting station two 500 kW. mercury arc rectifiers operating at 15,000 volts D.C. have been installed. The Athlone broadcasting station of the Irish Free State has two 230 kW. 13,000 volt rectifiers. The Hungarian subsidiary Company of the Standard Telephone Telegraph Co. also decided to use in the new Hungarian broadcasting station in the neighbourhood of Budapest a 500 kW. 22,000 volt metal clad mercury arc rectifier unit.

The most interesting development has been made in Germany, where previously converting plants of various types have been used. In the new broadcasting stations installed by the German Postal Authorities metal clad mercury arc rectifier replaced the formerly adopted motor generator sets, as well as the thermionic hot cathode rectifiers. The following German broadcasting stations have been equipped with metal clad mercury arc rectifiers :—

Zeesen	1 × 520 kW. and 1 × 585 kW.
Heilsberg	1 × 360 kW.
Langenberg	2 × 585 kW.
Breslau	2 × 585 kW.
Leipzig	2 × 585 kW.
Munich	2 × 585 kW.
Frankfort	2 × 100 kW.
Berlin	1 × 585 kW.
Hamburg	2 × 585 kW.
Freiburg	2 × 54.5 kW.
Adlershof-Berlin	2 × 45 kW.

All of these rectifiers operate under normal conditions at 6,000–13,000 volts. One of

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* MS. accepted by the Editor, October, 1933.

these rectifiers installed at Zeesen has been submitted to protracted tests for over a year under D.C. pressure up to 20,000 volts. The results reached with this rectifier at such high D.C. voltages were astonishing and showed that the further development of this special type of metal clad rectifier was a very promising field indeed.

High voltage metal clad rectifiers are at present the most reliable and economical converters on the market. There are several sound reasons for this claim. The experience gained with rectifier plants which have been working satisfactorily all over the world for years has formed an extremely valuable basis for the further development of this new type of rectifier.

Several important alterations had to be adopted for rectifiers used for voltages over 5,000 volts. The construction of the anodes and various auxiliaries are of a different character. The general layout of a high tension rectifier plant is somewhat similar to that usually adopted for mercury arc rectifier units used in railway service. Each of the rectifiers has 6 main anodes, 2 excitation anodes and an automatic ignition device. The cathode under the tank is usually electrically connected to the anodes of the transmitting valves. The negative rectifier pole is formed by the neutral point of the main transformer and it is connected to the earthed cathode of the transmitting valve.

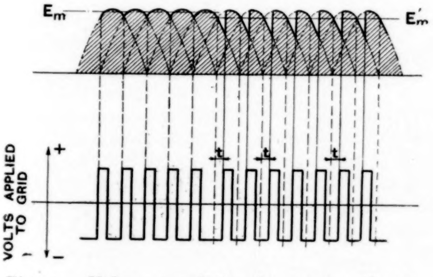


Fig. 1.—*Voltage regulation by means of controlled grids.*

On the primary side the set is protected by a 3-pole alternating current circuit breaker equipped with over-current relays. No circuit breaker is required on the D.C. side.

For the voltage regulation in high tension mercury arc rectifier plants three different arrangements can be adopted. These are: induction regulators, regulating transformers with step switches, and grid control. Induction regulators allow of obtaining a very satisfactory regulation curve, but lower the over-all efficiency of the plant as well as the power factor. Regulating transformers for step switches can be used with from 20 to 60 steps according to the system of connections. The regulation of the voltage thus obtained is not gradual but is in jerks from step to step. For general transmission service this drawback can be disregarded as adjustment of the voltage during service is seldom required.

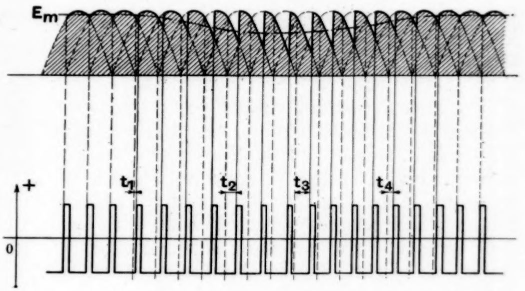


Fig. 2.—*Voltage regulation to various values by means of controlled grids.*

Voltage regulation by grid control as used in high voltage rectifier plants presents advantages which are common to both the above-mentioned methods of voltage regulation without the disadvantage of lowering the over-all efficiency and the power factor of the plant. The operation of grid control voltage regulation consists in the adjustment of the moment at which the arc strikes during the positive half wave. For that purpose negative and positive potentials are alternately applied to the grids from an auxiliary low-voltage D.C. source through a special contact maker. Only during the time for which the operation of the particular anode is desired is the positive potential applied through the contact maker. By the displacement of the contact maker it is possible to adjust the point at which the arc strikes. It is therefore possible to arrange that the arc always strikes with a constant time lag relative to the point on the positive half wave at which the arc would strike if the grid were not charged at all. The right-hand part of Fig. 1 shows the result of delaying the striking point. Current flows only during part of the positive half wave. It will also be noted that the mean value E′m of this undulating D.C. voltage is smaller than Em which is the mean value of the undulating D.C. voltage in the left-hand part on the figure, *i.e.*, where the striking point is not delayed. Fig. 2 shows that if the time lag t is varied (t_1, t_2, t_3, t_4) the effective mean value Em of the D.C. voltage is similarly varied, *i.e.*, the voltage on the D.C. side of the rectifier can be varied at will. Fig. 3 shows diagrammatically how to adjust time lag t by means of a contact maker which rotates synchronously with the A.C. supply. The position of the contact 5 controls the time lag t with the result that the D.C. voltage can be varied. The undulated D.C. voltage characteristic as shown in Fig. 2 is, of course, considerably smoothed by the transformer reactance and the overlapping which is a result of the latter. The wave filter devices, consisting of choke coils and condensers always available in broadcasting stations, reduces the undulations to values prescribed by the service of the transmitting system. The increase in the undulatory character of the direct current produced therefore does not have any undesirable results, so that this effect becomes only noticeable at very low voltages. As low voltages are only used at starting up, this defect can be disregarded as far as normal operation is concerned.

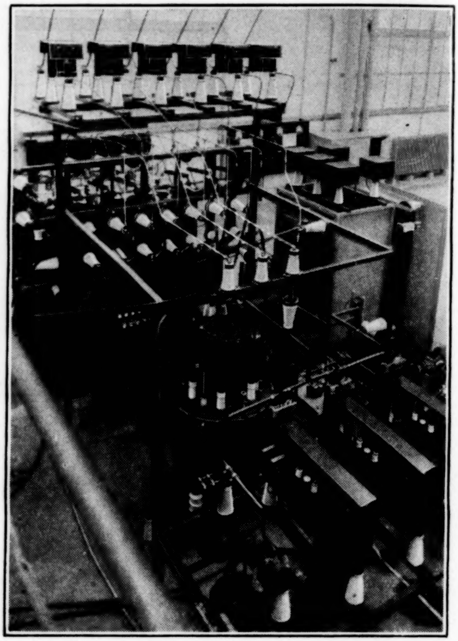


Fig. 4.—500 *kW.*, 20,000 *volts grid controlled mercury arc rectifier as installed at Zeesen.*

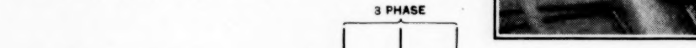
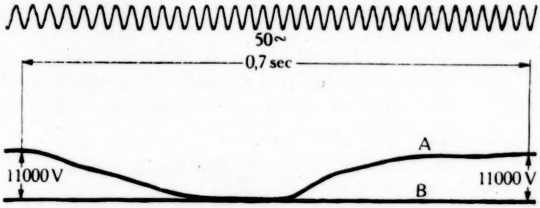


Fig. 3.—*Typical diagram of a grid controlled mercury arc rectifier unit :* 1—*control grid,* 2—*main anode,* 3—*resistors,* 4—*auxiliary d.c. source,* 5—*contactor,* 6—*synchronous auxiliary motor,* 7—*relay,* 8—*choke coil.*

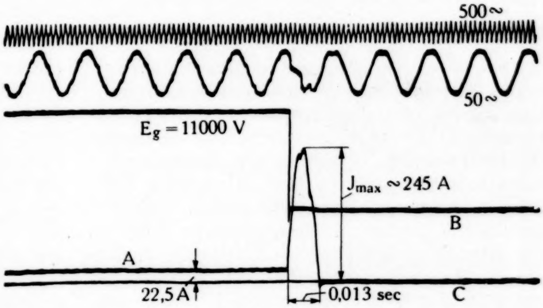
It should be mentioned here that the high voltage rectifier plant in Zeesen, as shown in Fig 4, has been equipped with grid control voltage regulation. Other plants of this type are being built. Fig. 3 shows a typical diagram of regulation of D.C. voltage with the help of controlled grids. The operation of the grid control voltage regulation is usually remote and actuated directly from the operator's desk in the transmitting room. By operating this remote control switch it is possible to raise or lower the D.C. voltage at will. The readings of the voltage are made on a voltmeter mounted in a special insulated switchboard.

A successful innovation was recently made in connection with the adoption of grid control voltage regulation of high tension rectifiers. This innovation consists in a very efficient protection against short circuits occurring inside or outside the apparatus. This is not only a protection of the rectifier, but of the transmitting station itself. The device in question consists in another utilisation of the control grids mentioned above. Each rectifier is equipped with a rapidly acting grid relay (7 in Fig. 3). This grid relay is connected to the secondary side of a current transformer which in turn is inserted in one phase of the incoming 3-phase supply. As soon as a short-circuit on the D.C. side causes the grid relay to act the current system feeding the grids is opened so that only negative potential is given to the grids. This prevents the heating of the anodes which are not operating. The anodes which happen to be heated are extinguished in less than ½ cycle. It is thus possible to prevent the transmitting valves being damaged by heavy short circuit currents, because the rectifier is cut out in such a very short space of time that the cathode of the valve has not time to get too hot, It is thus possible under certain conditions to avoid the use of protective resistances for the valves, which are a cause of great loss and diminish the over-all efficiency of the plant.



(*Left*) Fig. 5.—*Oscillogram of the voltage characteristic obtained by means of grid control on a* 585 *kW.*, 13,000 *volts rectifier.*

(*Below*) Fig. 6.—*Oscillogram of a short-circuit interrupted by grid control protection in a maximum time of* 0.013 *sec.*



The service voltage is reduced to its lowest value automatically after the rectifier has been cut out, so that starting up takes place under the lowest possible voltage, having regard for the special conditions of transmitting valve operation. The device can be arranged so that after restarting the pressure comes up again automatically to the value desired in a very short time.

A high voltage metal clad rectifier is thus in every respect the best converter at present on the market and can be adopted unreservedly for transmitting stations owing to its service reliability, high efficiency and general insensibility to short circuits, excellent pressure regulating facilities, compact design and, above all, unlimited length of life.

High-frequency Measurements on an Electron Oscillator*

By S. J. Borgars, B.Sc.Eng. (Hons.), A.C.G.I., D.I.C.

1. Introduction

THE study of the phenomena associated with the production of very short electro-magnetic waves is becoming of rapidly increasing importance. Ultra-short waves can be produced by triode electron oscillators by methods which are now well known and need not be elaborated here. It is desirable to have a means of measuring the H.F. currents, voltages, and power outputs of such oscillators. There are two factors, however, which give difficulty in making these measurements. One being the very low efficiency of an electron oscillator, consequently there is only a very small H.F. output, and hence the measuring apparatus has to be very sensitive. The other factor is the very high frequency of oscillation of an electron oscillator. This gives rise to considerable errors in the usual types of H.F. measuring instruments—valve voltmeters, hot-wire ammeters, etc.—and causes the stray capacities and inductances of the leads and internal wiring of the instruments to become important.

In this paper a method of making H.F. measurements is described, which uses the oscillatory circuit of the generator itself as the measuring instrument, and hence avoids errors due to subsidiary apparatus. The main features of the method are :—simplicity of apparatus, high sensitivity, ease of calibration on D.C., very small errors due to stray capacities and inductances. Some experimental results are indicated.

2. Method

The experiment consists in connecting a circuit of two parallel wires, *AB* and *CD*, across the source of H.F. under investigation, *i.e.*, between two of the electrodes of a triode electron oscillator—as indicated in Fig. 1.

One of the wires, *CD*, is connected to the negative end of the filament, and is regarded as the "earth," or return wire. The other wire, *AB*, is at H.F. potential, being connected either to the grid or anode of the valve, and is made as fine as is mechanically convenient. When the valve is oscillating H.F. currents are produced in the circuit *ABCD* which cause heating and corresponding expansion of the wire *AB*. From measurement of the expansion and previous calibration, the H.F. current in the wire is obtained, which enables calculation to be made of the oscillatory power output and also of the H.F. voltage at the valve electrodes.

3. Apparatus

The electron oscillator circuit used (Fig. 1) is of the simplest kind, the anode is returned directly to the negative end of the filament, and the grid raised to a positive potential. Control of oscillation is effected by varying the grid and filament voltages. Connections are made directly to the valve pins, small H.F. chokes being inserted in the grid and anode leads to confine H.F. currents to the circuit *ABCD*.

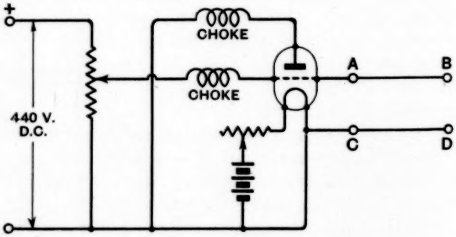


Fig. 1.—*Electron oscillator with parallel wire measuring circuit ABCD.*

In general, for the production of electron oscillations, best results are obtained by over-running the filament and applying a high positive voltage to the grid. Such conditions reduce valve life considerably. With the majority of valves, the electron bombardment of the grid causes it to become excessively hot, and it may even melt, also the rate of evaporation of the filament is considerable.

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* MS. accepted by the Editor, September, 1933.

The valve employed in the experiments was a Marconi type V.T.1.A., and was chosen because of the facility with which it could be made to oscillate at comparatively low grid and filament potentials. The electrodes are cylindrical, and have the following characteristics :—

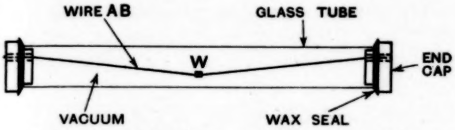

Fig. 2.—*Method of mounting wire AB.*

Rated filament voltage = 4 volts
Anode diameter = 1.1 cm.
Grid diameter = 0.4 cm.

It was decided to mount the wire *AB* horizontally, as indicated in Fig. 2, and take the sag at the mid-point of the wire as a measure of its expansion—any given sag being greater than the linear extension producing it.

The wire is of 47 S.W.G. Eureka suspended longitudinally inside a glass tube, and soldered at each end to a small brass cap which fits into the tube. A small weight *W* attached to the centre of the wire to keep it taut, also serves as a point of observation. The ends of the wire are as near to the inner surface of the tube as possible, giving maximum space for the wire to sag. This eccentric positioning of the wire also has the advantage that when not in use, the tube can be rotated in its holder so as to bring the weight *W* to rest on the side of the tube, hence relieving the wire of strain. The end caps are sealed to the tube by wax, and the tube evacuated to a very low pressure. This evacuation is done to keep the wire temperature as far as possible independent of changes of external temperature, also by reducing loss of heat due to convection from the wire to the tube, to ensure that any given current produces the maximum increase in temperature of the wire.

The return wire, *CD*, is of 16 S.W.G. copper, and is mounted parallel to the glass tube. The valve is mounted on the same base as the parallel wire system. The base itself is supported on compressed rubber to reduce vibration of the wire in the tube.

The sag of the wire is measured by observing the weight *W* with a microscope having a graduated eyepiece.

To determine the H.F. current in the wire from measurement of the sag previous calibration is required ; this may be done by D.C. without very serious error—corresponding values of sag and current being recorded. A calibration curve is shown in Fig. 3.

4. Experimental Results

H.F. current in the wire *AB* was detected for certain values of grid and filament voltages, V_g and V_f.

Variations of H.F. current, I_h, and the anode current, I_a, as the grid voltage is increased, are indicated in Figs. 4 and 5, the wire *AB* being connected to the anode and grid respectively. Filament voltage was kept constant at 5.3 volts. In agreement with general theory, the presence of appreciable anode current coincides with the production of H.F. current, also the two currents are practically proportional.

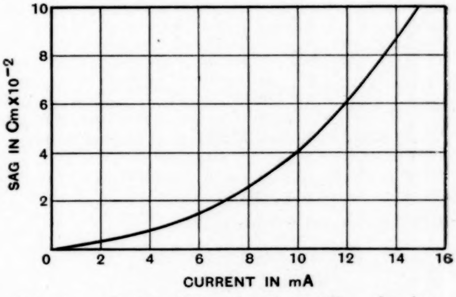

Fig. 3.—*Calibration of wire AB, showing variation of sag of the weight W with current in the wire.*

The grid static characteristic of the valve ($I_g - V_g$) showed that saturation of the grid current occurred at a grid voltage of about 140 volts. No H.F. current was detected for grid voltages below this value.

5. Calculations

For the parallel wires *AB* and *CD* let :—

L = Distributed inductance in henries/cm.
C = Distributed capacity in farads/cm.
R = Distributed resistance in ohms/cm.

G = Distributed leakance in ohms/cm.
l = Length of wires in cm.

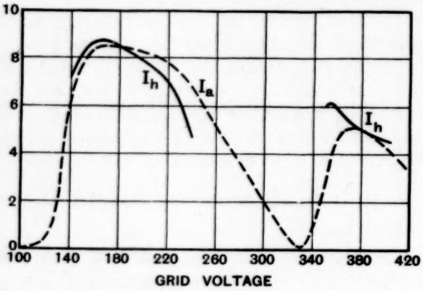

Fig. 4.—*Variation of anode current, I_a, and H.F. current, I_h, with grid voltage—wire AB connected to anode.*

Then for an applied H.F. voltage, V_h, across the ends of the wires, the H.F. current, I_x, at a point on the wires x cm. from the valve is given by :—

$$I_x = \frac{V_h}{Z_0 \, . \cosh \gamma l} \, . \sinh \gamma (l - x)$$

where :—

$$\gamma = \sqrt{(R + j\omega L)\,(G + j\omega C)}$$

and

$$Z_0 = \sqrt{\frac{R + j\omega L}{G + j\omega C}}$$

The current measured by the sag of the wire is the average heating current over the whole length of the wire, and is given by :—

$$I_h^2 = \frac{1}{l} \cdot \left(\frac{V_h}{Z_0 \, . \cosh \gamma l}\right)^2 \int_0^l \sinh^2 \gamma (l - x) \, . \, dx$$

which gives on integration :—

$$V_h = \frac{I_h \, . \, Z_0 \, . \cosh \gamma l \, . \sqrt{2 \, . \, l}\, .}{\sqrt{\frac{1}{2 \, . \, \gamma} \, . \sinh 2 \, . \, \gamma l - l}}$$

This enables the H.F. voltage at the valve electrodes to be calculated.

To see the order of the voltage produced a numerical example is given. The maximum H.F. current indicated is obtained with the wire *AB* connected to the grid and at $V_g = 160$ volts, where $I_h = 10$ mA (see Fig. 5). The constants of the circuit are as follows :—

Length of wires = 58 cm.
Distance between wires = 2.5 cm.
Distributed resistance = 2.34 ohms/cm.
Wavelength (measured on a separate Lecher wire system) = 90 cm.

Substituting these values, neglecting the leakance G, the H.F. voltage works out to be 7.13 volts.

The output oscillatory power, and the efficiency of the valve, regarded as a source of high frequency, may be obtained as follows :—

Output oscillatory power $= I_h^2 \, . \, R$ (approx.)
$= 13.5$ mw.
Input power $= Vg. \, Ig.$
$= 8{,}320$. mw.
Efficiency of oscillator $= 0.16$ per cent.

6. Summary

Measurement of the H.F. output of a low power triode electron oscillator is made by connecting a parallel wire circuit to the valve, one of the wires being sufficiently fine for the H.F. current to cause appreciable heating and expansion of the wire. Previous calibration on D.C. enables the H.F. current to be obtained by measurement of the expansion.

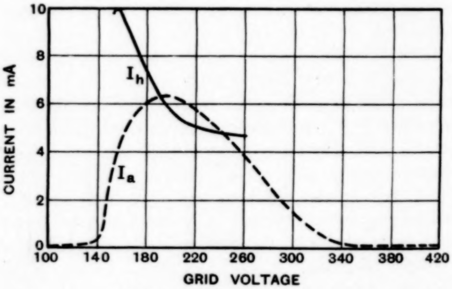

Fig. 5.—*Variation of anode current, I_a, and H.F. current, I_h, with grid voltage—wire AB connected to grid.*

Calculation is made of the H.F. voltage at the electrodes, also of the oscillatory power output, and efficiency.

General theory is confirmed, as it is found that variation of anode current corresponds to a similar variation of H.F. current.

Measurement can be made of H.F. currents down to about 5 mA, this corresponding to an output power of about 4 mw.

A Velocity-Modulation Television System

Paper by L. H. Bedford, M.A., and O. S. Puckle. A.M.I.E.E., read before the Wireless Section, I.E.E., on February 7th, 1934

Abstract.

THE paper describes a system developed in the laboratories of Messrs. A. C. Cossor. A short introductory section points out that the conception of the velocity-modulation principle dates back to 1911, although the first practical realisation of the principle was achieved by von Ardenne only in 1931.

The basic idea underlying the velocity-modulation principle is to obtain light-intensity variations in the received picture by varying not the instantaneous intensity of the scanning spot but its instantaneous scanning velocity, *i.e.*, its speed of traverse over the screen, the actual light-intensity of the scanning spot remaining constant. The apparent brightness of an element ds is proportional simply to the time taken by the spot to traverse the element, hence the apparent brightness is inversely proportional to the local instantaneous scanning velocity. This represents the possibility of obtaining light and dark in a received picture without actual modulation of the spot or ray intensity, and is therefore ideally suited to television reception by means of the conventional cathode-ray oscillograph.

In view of serious practical difficulties in the way of obtaining faithful tone reproduction by pure velocity modulation the authors were led to consider the possibility of transmitting a velocity-modulated picture at low contrast-level, and superposing intensity modulation upon it at the receiving end. This system proves to be a remarkably advantageous combination of the two principles, since both kinds of modulation work at their best only when called upon to operate over a relatively restricted range. Indeed the intensity-modulation requirements are so far relaxed by the presence of velocity modulation that the ordinary type of gas-focused oscillograph tube, which shows very poor modulation characteristics, is reasonably satisfactory.

As the spot is at its full brightness in the light portions of the picture and is dimmed only in the dark places the intensification process involves only the abstraction of light from places where its presence is detrimental. In practice the comparison of intensified and unintensified pictures is emphatically in favour of the former. The authors express the opinion that only with the addition of intensification does the velocity-modulation principle become a practical proposition.

Fig. 1* shows a purely schematic version of the transmitting circuit (for a stationary picture) by which velocity-modulated scanning, and the appearance of the picture on the transmitter, is brought about.

The screen-grid valve V_1, condenser C_1, and gas-discharge triode or thyratron V_2, constitute a time-base circuit, the valve V_1 forming the "constant current" charging element, in view of its being operated with the plate voltage well above that of the screen, that is to say in the saturated part of its anode-current/anode-voltage characteristic. The instantaneous charging current is determined from instant to instant by the voltage on the grid of V_1, which voltage is actually the output of the photo-cell amplifier. The bias on the grid of the thyratron V_2 determines, at least nominally, the voltage amplitude of the time-base sweep. The cathode of V_2 is connected to one of the X deflector plates (Px_1) of the oscillograph, the opposite plate (Px_2) being taken to a biasing potentiometer for the purpose of shifting the picture. The arrangement thus constitutes a time-base which provides a scanning sweep whose speed is modulated by the instantaneous amount of light falling on the photo-cell, and a rapid fly-back on the occasion of each discharge of the thyratron. This fly-back is so rapid as to be invisible, so that it is not necessary to quench the spot on the fly-back in order to obtain a correct picture.

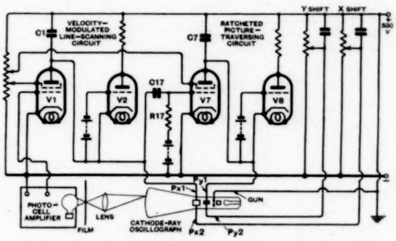

Fig. 1.

The type of scanning described above has been termed "constant-voltage scanning," the lines being all of the same "voltage length."

Coming to the picture-traversing circuit, the screen-grid valve V_7, condenser C_7, and thyratron V_8, constitute the traversing time-base. It will be appreciated that, unless constant-time scanning is used in the line-scanning circuit, it is not satisfactory for the traversing time-base sweep to be uniform; for, if this were the case, the scanning lines would not be straight, and the pitch would be opened out in the bright portions of the picture. Two alternatives present themselves: either (*a*) The traversing velocity may be modulated along with that of the line scanning, in such a way that the two velocities hold a constant ratio; or (*b*) the scanning line may be moved on in a stepwise manner between consecutive lines, the magnitude of the step being fixed and independent of the time taken by the line. Either of these arrangements has the effect of reducing the 2-dimensional scanning raster to a single degree of freedom. The latter alternative, which may be termed a "ratchet" arrangement, is adopted in the present case.

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*The authors' original figure-numbers are adhered to throughout.

In Fig. 1 the ratcheting effect is obtained thus. The condenser C_{17} and resistance R_{17} form a species of differentiating circuit, and the high rate of change of voltage corresponding to the discharge of V_2 causes a pulse of voltage to appear across the resistance R_{17}; the bias on the grid of V_7 is such as to cause the anode current to be completely cut off except on the occasion of the pulse. As all the pulses are similar, and as V_7 is operated on the saturated part of its anode-current/anode-voltage characteristic, it follows that equal increments of charge are fed into condenser C_7 at every line fly-back, and so the requisite ratchet motion is obtained.

It is now convenient to consider the wave-form of the scanning deflector voltage which characterises the above arrangement, for it is this voltage which has to be conveyed, directly or indirectly, to the receiving oscillograph in order to reproduce the velocity-modulated picture. Fig. 2(*a*) shows an extremely simple picture to be transmitted, consisting of a white rectangle in the middle of a dark field. AB and CD represent a pair of consecutive scanning lines, the faint line BC representing the fly-back. In Fig. 2(*b*) the corresponding deflector-plate voltage (on Px_1 of the transmitter) is plotted against time, whilst underneath this curve its time derivative is plotted to the same scale. (Fig. 2*c*). The voltage corresponding to the scanning line AB rises steeply at first whilst the spot scans rapidly over the dark field, then more slowly as the spot moves over the white rectangle, and again steeply as the spot moves over the dark field; then follows a rapid fall of voltage corresponding to the line fly-back; in this portion of the curve the transparency variations of the film produce no effect, as the discharge valve takes control. The derived curve (Fig. 2*c*) is very much like the curve which would correspond to the transmission of the same picture in the intensity-modulation manner, except that the time scale is stretched in the light and compressed in the dark portions of the picture.

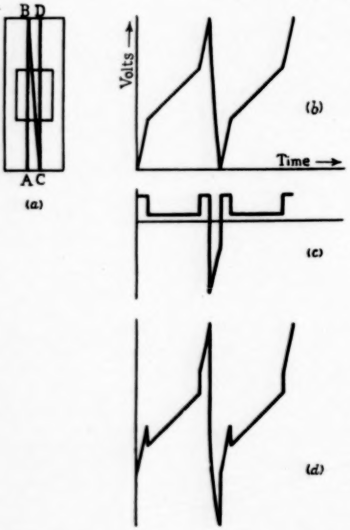

Fig. 2.

Practical Transmitting Circuit.

The practical transmitting circuit shown in Fig. 3 differs from that of Fig. 1 in many points of both detail and principle; of these differences the following may be listed in advance. (1) Addition of timer circuit, providing pulses of picture frequency (25 cycles per sec.). (2) Provision of facilities ("chasing circuit") for transmission of moving pictures from a uniformly running film. (3) Substitution of thyratron V_2 of Fig. 1 by a pair of hard valves, V_2 and V_3 (Fig. 3). (4) Improved ratchet mechanism involving the ratchet driver valve V_4 (Fig. 3). (5) Picture synchronising signal impressed via "locking valve V_5," on scanning circuit in the form of a temporary cessation of scanning at the end of the last line. (6) Inclusion of resistances R and R' in series with the condenser C_1. (7) Provision of output valve V_6 with condenser-resistance potentiometer input and 500-ohm output for transmission of signal to line or radio transmitter.

The last three features are concerned more strictly with the transmission-link and receiver aspects of the case, and, except for item (5), which plays a fundamental role in the transmitting circuit, can be left out of consideration here.

The valve V_1, which belongs electrically to the scanning panel, is located physically in the photo-cell amplifier, in order to save wiring capacitance on the grid side. A pentode is used for this position being found to give better saturation characteristics than a tetrode, and pentodes were therefore adopted for all the "constant-current" charging valves, viz.: V_1, V_7 and V_{11}.

The substitution of the hard valves V_2 and V_3 for the thyratron V_2 of Fig. 1 was an important step as thyratrons were found to be erratic at the higher frequencies corresponding to a succession of dark scanning lines.

In the case of the hard-valve circuit the operation is as follows. During the charging of the condenser C_1, the valve V_2 takes no anode current owing to its being biased beyond cut-off by the drop in the resistance R_3 in the plate circuit of V_3. As the charging continues, the voltage across V_2 rises until a point is reached where anode current commences to flow; this causes a voltage drop over the resistance R_2, which is fed through condenser C_{23} on to the grid of the valve V_3. This reduces the current in R_3; hence the grid voltage of V_2 rises, the anode current increases, and the action is cumulative. At the end of the discharge the current in R_2 drops, the cumulative action is reversed, and the circuit resets itself for the next charging stroke.

The anode of the valve V_3 makes a large excursion in voltage in the positive direction on the occasion of every fly-back. It is therefore tempting to use this voltage for the ratchet drive on the grid of V_7, instead of using the differentiating circuit of Fig. 1. As, however, the rise of the anode voltage of V_3 is checked by the grid current of V_2 during the discharge, it is preferable to use a separate ratchet driver valve V_4, whose grid and screen are paralleled to those of V_3, but whose anode is free of the load of the grid of V_2. This anode is taken to positive H.T. *via* a resistance R_4, and drives the grid of the ratchet valve V_7 *via* the condenser C_{47}; the resistance R_7 biases back the grid until it takes only a small excursion into grid current on each line fly-back; this bias is sufficient to hold the anode current of V_7 completely cut off during the actual scanning lines.

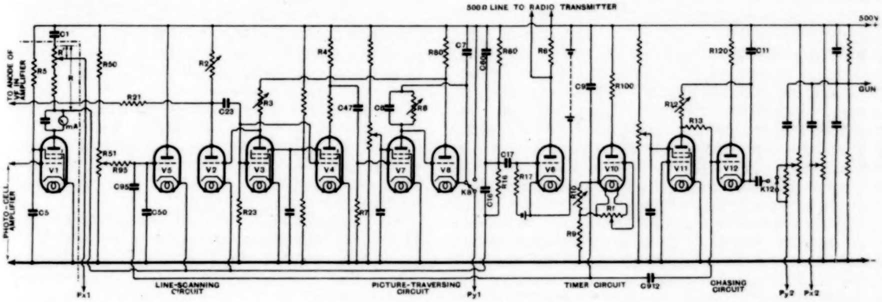

Fig. 3.—*Scanning panel.*

The neon thyratron V_8, which serves as discharger for the ratcheted picture traverse, is biased by the voltage drop over resistance R_8 in the anode circuit of V_7. This anode current being pulsatory, it is necessary to provide a condenser C_8 to hold up the bias between pulses. Herein lies the essence of the picture synchronising process, in that the time-constant C_8R_8 is made only long enough to hold up for one scanning line of maximum length, and any delay impressed on the scanning longer than this period causes the thyratron V_8 to discharge.

Such a delay is impressed every 1/25th sec. by means of the timer circuit. This consists of the resistances R_9, R_{10}, condenser C_9, and thyratron V_{10}, which constitute a simple (non-linear) time base. The circuit is adjusted to pulse at 25 cycles per sec., being synchronised on to the 50-cycle mains by means of the potentiometer R_f across its heater.

As a shunt path to the discharge valve V_2 there is placed a similar valve V_5, which acts as a "locker." The grid of this valve is biased by the potentiometer R_{51} to a potential lower than that of the grid of V_2, so that V_5 passes no anode current within the excursion of cathode voltage corresponding to the picture lines. The timer pulse is fed on to the grid of V_5 *via* the condenser potentiometer $C_{95}C_{50}$, and is such as to make the grid of V_5 more positive than that of V_2. In this condition V_5 robs V_2 of anode current, and the scanning is held up. After the timer pulse, the grid voltage of V_5 falls back to its more negative value on account of the collapse of the time-constant circuit $C_{50}R_{95}$, and only when the grid voltage of V_5 falls below that of V_2 does the line discharge occur. The time-interval allowed for the scanning stop is adjusted by the setting of the potentiometer R_{51}, and is arranged to be rather longer than the longest possible line time. The time-constant circuit C_8R_8 is adjusted to collapse far enough within this period to ensure discharge of V_8.

The circuit so far described is all that is necessary for the handling of a stationary picture. For dealing with moving pictures it is naturally desired to scan a uniformly running film rather than the intermittently moving film of cinematograph practice, since the latter would involve a loss of scanning time of the order of 25 per cent. To provide this facility, a fourth time-base circuit, termed the "chasing circuit," is added. The film is run uniformly through the gate at exactly 25 frames per sec., this being ensured by the use of a synchronous driving motor; the film is "phased" by means of a take-up roller so that the picture-change point coincides with the timer pulse, the latter being synchronised off the same mains as the driving motor. The chasing circuit superposes a linear saw-tooth motion on to the whole of the scanning, of such direction and magnitude as exactly to neutralise the motion of the film. The fly-back of this motion, which constitutes the frame change, is synchronised from the timer discharge by means of the condenser C_{912}. (In a previous arrangement the functions of timing and chasing were combined in a single time-base circuit.)

This particular form of chasing compares favourably with the procedure, known in intensity-modulation systems, of collapsing the scanning to a single line and allowing the film motion to provide the traverse, since by means of the new method it becomes unnecessary to transmit the blank bars between successive frames.

PHOTO-CELL AMPLIFIER.

The design of the photo-cell amplifier, which has proved one of the most difficult problems in the development, has to meet the following requirements. (1) Voltage gain of the order of 5,000 times. (2) Effectively level frequency-characteristic from 25 to 240,000 cycles per sec. (3) A minimum of phase distortion. (4) Minimum phase-delay. (5) Total valve and resistance noise to be a minimum. (6) Low level of microphonic noise. (7) Freedom from instability of all kinds. (8) Freedom from pick-up, *e.g.*, of the scanning voltages. (9) Preferably should run off mains.

The fulfilment of requirements (2), (3), and (4), calls for compensation for the stray capacitance across the photo-cell, and compensation for the stray capacitances across the anode resistances of the amplifying valves, all of these stray capacitances themselves being kept at a minimum. Unfortunately this is not all the compensation necessary; there is further required compensation for the after-glow of the fluorescent material of the scanning oscillograph.

The above factors are fully considered in the paper, leading to the complete amplifier circuit shown in Fig. 7.

This amplifier consists of six stages, each of the amplifying valves (V_A, V_B, . . . V_F) being provided with a partner valve (V'_A, V'_B, . . . V'_F) operating in paraphase. The object of these apparently idle valves is threefold: (*a*) To secure low-frequency stability by balancing out the a.c. currents in the decoupling condensers; (*b*) To avoid non-calculable low-frequency distortion due to the above currents; and (*c*) To reduce the amount of shielding required to secure high-frequency stability.

To avoid unnecessary stray capacitances such as would be introduced by the Miller effect with triodes, it was an obvious step to use screen-grid valves throughout. To avoid the necessity for separate voltage supplies to the screens, a further step was to make these valves screened pentodes; this permits the screens to be fed from the same decoupling condensers as the anodes, the latter actually operating at a potential below that of the screens owing to the drop in the anode load resistances.

The Transmission Link.

In discussing the transmission channel the authors refer back to the resistance R in Fig. 3. It is shown that in Fig. 2, the wave-form (*b*) is the displacement voltage, (*c*) is proportional to its derivative and is in fact the voltage across R_7, while (*d*) is the superposition of these two and represents the transmitted signal. By the choice of suitable time-constants it is then arranged that when a voltage wave corresponding to Fig. 2(*d*) is applied to the grid of a valve V in Fig. 13, a voltage corresponding to that of Fig. 2(*b*) appears on the anode, while a voltage proportional to Fig. 2(*c*) appears across R''.

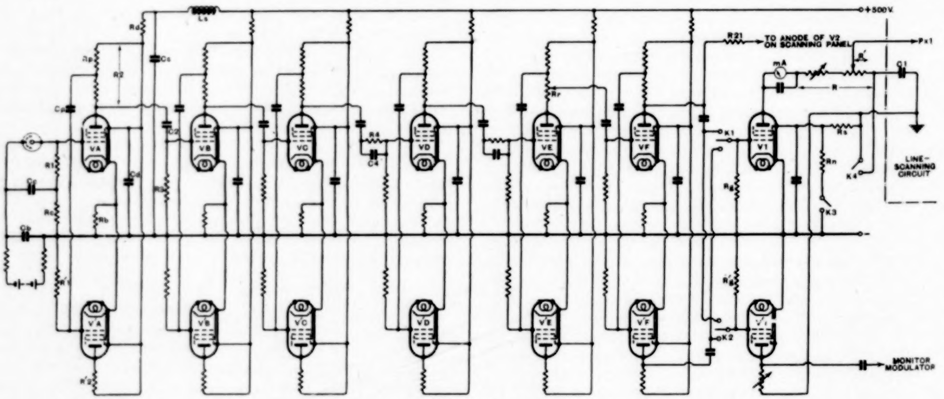

Fig. 7.—*Photo-cell amplifier.*

The Television Receiver.

This section is concerned only with the television part of the receiver, and not with the radio portion; the television portion is, however, designed to work from a low level of signal voltage such as could easily be obtained from a detector.

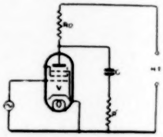

Fig. 13.

The receiver comprises in principle a separating circuit such as that of Fig. 13, for separating out the displacement and velocity components of the signal, a line-scanning amplifier for the displacement voltage, giving a sufficient voltage output for providing the horizontal scanning, a ratcheted time-base for the picture-traversing. and an amplifier for the velocity-component voltage for intensification.

In the practical receiver, whose circuit is shown in Fig. 14, the separating stage is combined with the paraphase output stage of the line-scanning amplifier. The input, which is fed straight from the wire-line on to a 500-ohm potentiometer R_1, is tapped off at a suitable level and passed *via* a blocking condenser C_1 on to the grid of valve V_1. The latter drives its paraphase partner V'_1 in the same manner as that described for the photocell amplifier at the transmitter. The anodes of V_1 and V'_1 are fed from a common decoupling circuit, the condenser of the latter being shunted by a neon stabiliser tube for the purpose of smoothing out mains fluctuations on this stage. The anode of V_1 supplies a small-scale copy of the compound voltage on the anode of V_1 at the transmitter, whilst V'_1 supplies a similar copy in opposite phase. These two anodes drive the grids of the paraphase output valves, the latter being screened pentodes. The anodes of these pentodes are connected directly to the Px_1 and Px_2 deflector plates of the receiving oscillograph and face the equal resistances R_2 and R'_2;

the latter are shunted by equal condensers C and C' and low resistances R and R' to earth. The time-constants $(C + C_S)R_2$ and $(C' + C_S)R'_2$ are each made equal to the time-constant C_1R at the transmitter, C_S being the stray capacitance in each case. Herein lies an incidental but extremely important advantage of the compound form of signal, for the resistances R_2 and R'_2 can be made relatively high, *e.g.*, from 30,000 to 50,000 ohms, which could not be done in the case of the simple displacement signal on account of frequency-characteristic droop; in the present case, frequency-characteristic droop is actually required and has to be encouraged by increasing the stray capacitances several fold with the condensers C and C'. Because of this high output-resistance the gain of the output valves is high, the grid swing is small, and the valve characteristics do not depart seriously from linearity; such distortion as does occur is cancelled out by the paraphase arrangement.

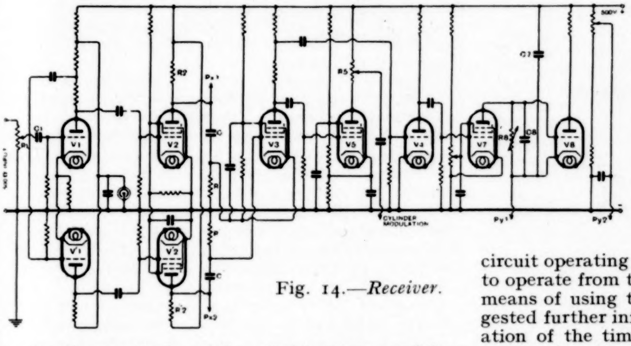

Fig. 14.—*Receiver.*

Across the resistances R and R' appears a voltage proportional to the instantaneous scanning velocity. This is passed through two amplifying stages V_3 and V_5, and provides the intensification voltage which is taken on to the Wehnelt cylinder of the oscillograph. The valve V_3 also drives a further valve V_4, which acts as ratchet driver for the picture-traversing circuit. The latter consists of components strictly analogous to the picture-traversing circuit at the transmitter, namely the ratcheted charging valve V_7, the time-base condenser C_7, and the discharge thyratron V_8; the latter is biased by the time-constant circuit C_8R_8, which is again wholly analogous to that at the transmitter, the time-constant being adjusted so as to allow V_8 to fire within the delay interval in the scanning sent out by the transmitter.

The controls at the receiver are extremely simple. There is no synchronising adjustment. The additional controls are "intensification volume control," R_5, and the oscillograph focussing, namely, the cylinder biasing potentiometer.

In a concluding discussion of results and prospects the authors state that a 9in. diameter screen appears a satisfactory compromise between what is desirable and what is practical, and tubes of this size have already been made. Very considerable improvements may also be looked for with the development, now in hand, of a "hard vacuum" oscillograph for the receiver. A wide range of screen materials has been examined and a mixture evolved which gives a satisfactory white light response. It is thought that the results obtained to date indicate that the system has reached a practical footing and is vindication of the fundamental merits of the system.

A cinema film was shown illustrating the quality of reception, and showing also the effect of the intensification process, the improvement as scanning lines were increased from 40 to 200 and the general entertainment value of television reception from films.

Discussion

A lengthy discussion followed the reading of the paper, centred chiefly round details given in the paper. In opening the discussion MR. J. F. HERD referred to the high technical value of the paper in relation to the cathode-ray oscillograph and its associated circuits, as well as in the subject of television. The author's method of using two hard valves for the generation of a saw-tooth voltage was very elegant. The "timing" circuit operating at 25 per second was a simple one to operate from the 50-cycle mains and gave a good means of using these mains as a control. He suggested further information in the paper on the operation of the timing circuit in relation to the line scan, and on the operation of the "chasing" circuit.

MR. A. BLUMLEIN discussed the mixture of components (in Fig. 2) in the photo-cell circuits and raised difficulties in the use of the Zworykin iconoscope in relation to the photo-cell amplifier when used as a velocity modulator.

MR. H. M. DOWSETT enquired as to the change of spot dimensions with differing velocities during the scan.

MAJOR A. G. CHURCH referred to the general position of television in Britain and Germany. He did not share pessimism as to the direct television transmission of subject matter. If intensity modulation was to be used, why not develop it? He thought that mechanical scanning and intensity modulation would finally hold the field. The subject of television raised a number of interesting physical problems, for example, the photo cell, the radio channel, etc.

MR. C. O. BROWNE criticised the velocity modulation system and also thought that intensity modulation would be the final system used.

MR. N. M. RUST raised some points of the photo-cell amplifier in relation to grid decoupling and to the limits of stability due to the paraphase system.

DR. L. E. C. HUGHES made some queries as to phase effects with the combined transmissions of Fig. 2 (d).

MR. P. W. WILLANS said that the comparison of competing methods must rest on results obtained in practice; for example, maintenance of synchronisation and cost of operation. As regards film or direct transmission he had no doubt that public taste would be towards the latter.

The authors briefly replied to some of the points raised, reserving more detailed reply for written communication.

Abstracts and References

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PROPAGATION OF WAVES

IONOSPHERIC INVESTIGATIONS IN LOW LATITUDES.—I. Ranzi. (*Nature*, 6th Jan., 1934, Vol. 133, p. 29.)

This letter gives important results from observations on the state of the ionosphere at Asmara (15°20′N, 38°55′E) from September to November, 1933. The maximum ionisation for vertical reflection from region F occurs towards 6 p.m. and not at noon, as in middle latitudes; the layer is extremely thin. Towards 2 a.m. a very strong increase of critical frequency for region F is frequently noted; the echoes become very complex. The occurrence of nocturnal ionisation, particularly in the early hours of night, is also noted in region E. The only logical suggestion at present formulated for the explanation of the effects is that ionisation is produced by the electric fields of thunderstorms.

RESULTS OF OBSERVATIONS OF THE APPARENT HEIGHT OF REFLECTION FOR 3 000 KC/S WAVES IN THE PERIOD 16TH MAY, 1931, TO 28TH NOVEMBER, 1932.—I. Ranzi. (*La Ricerca Scientifica*, 30th Nov., 1933, 4th Year, Vol. 2, No. 10, Supp. pp. 63–69.)

The equipment used, in which the echo-recording apparatus is installed at the transmitting station, has already been described (*see* 1933 Abstracts, p. 559, and back references). The writer describes how, on causing the receiver to oscillate and detuning it slightly, the arriving echoes combine with these oscillations to form beats, which are clearly visible in the oscillogram and which give a clear indication of the position of the echoes in the latter. When, however, the receiver is taken farther away from the transmitter than 500 metres, the beat curve becomes very unstable: this result (of fundamental importance to the method) is explained by the interaction, at close quarters, of transmitter and oscillating detector valve, the latter exerting a synchronising action on the former *at the beginning of the signal when the amplitude is small*: the phasing thus started persists practically unchanged throughout the whole time of the signal. A daily table of layer heights is given at the end of the paper.

THE DETERMINATION OF THE DIRECTION OF ARRIVAL OF SHORT RADIO WAVES.—H. T. Friis, C. B. Feldman and W. M. Sharpless. (*Proc. Inst. Rad. Eng.*, January, 1934, Vol. 22, No. 1, pp. 47–48.)

Phase-difference method: method depending on difference in output of two aerials with contrasting directional patterns. Transmission of short pulses as a means of resolving the composite wave into components separated in time: Transatlantic results. "To the extent that we have been able to resolve the propagation into separate angles, the separate angles are found not to be erratic; they vary slowly. There appears to be at least a qualitative relation between angle and delay; the greater the delay the greater the angle above the horizontal. The horizontal and vertical components of the entire group of waves have the same mean angle, and *probably* the horizontal and vertical components of each separate wave arrive at substantially the same angle." The results suggest the practicability of improving radiotelephonic quality by using receiving aerials which by directional discrimination reduce the number of waves received. As regards direction finding, it is found that the horizontal angle spread is comparatively small, and that the mean angle coincides within a few degrees with the great circle path.

THE DISPERSION FORMULA FOR AN IONISED MEDIUM.—D. R. Hartree. (*Nature*, 16th Dec., 1933, Vol. 132, pp. 929–930.)

This letter replies to two letters by Tonks (Abstracts, January, p. 28) which disagree with the inclusion of the Lorentz polarisation term in the expression for the refractive index of an ionised medium for waves of given frequency. The present letter points out various unjustified assumptions, as to the contributions from the positive charges, in Tonks' arguments, while admitting the presence of an unjustified assumption in the writer's own earlier derivation of the Lorentz formula for this case (1929, p. 441, and 1931, p. 143). "A much more careful and critical investigation is necessary before the question [of inclusion of the Lorentz term] can be answered with certainty."

REFRACTION OF IONISED MEDIA [and the Omission of the Lorentz Polarisation Term].—C. G. Darwin. (*Nature*, 13th Jan., 1934, Vol. 133, p. 62.)

This letter gives reasons for concluding that the Lorentz polarisation term should not be included in expressions for the refractive index of a gas composed of free electrons moving among ionised atoms, as in the ionosphere. The inclusion of the term is "an expression of the fact that the systems to which it applies are governed by a law that is not electromagnetic—the exclusion principle which prevents one atom from penetrating another." *See* also Norton (January Abstracts, p. 28), Tonks (same page), and Hartree (these Abstracts, above).

ECHOMESSUNGEN AUS DER IONOSPHÄRE MIT DEM SCHLEIFENOSZILLOGRAPHEN (Measurements of Echoes from the Ionosphere, with a Loop Oscillograph [and the Occurrence of Steep-Angle Reflections from Heights around 1 000 Kilometres]).—M. Bäumler and H. Mögel. (*E.N.T.*, November, 1933, Vol. 10, No. 11, pp. 453–456.)

A preliminary communication on measurements of echo reflection from the ionosphere, made since March, 1933, on the Polar Year days of first and second order. Similar experiments have already been referred to in 1933 Abstracts, pp. 613–614. The wavelength chosen for the 24-hr runs was 56.6 m; the emitter was in Döberitz and the receiver in Beelitz, 39 km away. A Siemens universal loop oscillograph was used as the recording apparatus; the records obtained show that it may be very successfully employed for the purpose and is particularly valuable when it is desired to record on two or three wavelengths simultaneously. Examples of the records are given, showing multiple reflections from F layer, occasional reflection from E layer, and double refraction from F layer. Records of the 7th and 8th June, 1933, show scattered reflection with an equivalent height of 750 km, appearing about 11 p.m. while F reflections are still present and lasting until about 3 a.m., when its equivalent height had increased to about 1 000 km. The origin of these reflections is unknown; it is hoped to determine it by directional investigation. Nocturnal E reflections also occur from midnight onwards. The long-delay echoes appear again after 5 a.m. from an equivalent height of 800 km, which decreases after 7 a.m. to 700 km; after this they disappear and do not reappear until 11 p.m. Reflection from F layer began about 7.10 a.m. from an equivalent height of 370 km, with double refraction, which also occurs again spasmodically between 11 a.m. and 2 p.m. The echoes were practically the same with reception on (*a*) a horizontal and (*b*) a vertical dipole. Double reflections from a height of 500 km are shown shortly before midnight on June 8th and from a height of 1 000 km between 11.20 p.m. and 1 a.m., so that this radiation is assumed to have a steep angle of incidence. There was very little terrestrial magnetic activity during the time the records were taken.

THE DIURNAL VARIATION OF THE INTENSITY OF WIRELESS WAVES REFLECTED FROM THE IONOSPHERE [and Magneto-Ionic Echo Doubling in E Region as well as F].—F. W. G. White. (*Proc. Phys. Soc.*, 1st Jan., 1934, Vol. 46, Pt. I, No. 252, pp. 91–106.)

Reflection from the ionosphere during the early morning period from about 2 a.m. until about 9 a.m. is the subject discussed in this paper. "The influence on the intensity of electron-limitation and of absorption-limitation is discussed, in the light of theoretical ionisation curves given by Chapman (Abstracts, 1931, p. 202). The experimental observations described show that the magneto-ionic doubling of the echo, which has been observed by Appleton and Builder (1932, p. 155, and elsewhere) for the F region, occurs also for the E region" but is only observable for a short period owing to the total absorption of the extraordinary ray which soon occurs.

SOME AUTOMATIC RECORDS OF WIRELESS WAVES REFLECTED FROM THE IONOSPHERE [Indications of Triple Stratification below F Region: Relation between Nocturnal Ionisation and Magnetic Disturbances and Thunderstorms].—J. A. Ratcliffe and E. L. C. White. (*Proc. Phys. Soc.*, 1st Jan., 1934, Vol. 46, Pt. I, No. 252, pp. 107–115.)

This paper describes records obtained with an apparatus previously described (1933 Abstracts, p. 495). The observations extended over a period of 14 months, the wavelengths used being generally 75 and 150 metres. "They indicate that the region below the F region may be triply stratified and consist of the intermediate region (effective height approx. 120–180 km), the E region (effective height approx. 100–120 km) and the e region with an effective height which is always nearly 105 km, within ± 5 km. The e region is shown to be intermittent in its occurrence, and is identified with the 'nocturnal E region' mentioned in previous papers. The temporal variation of the ionisation in these three regions is discussed. . . . It is shown that if the nocturnal ionisation was unrelated to magnetic disturbances the probability of the observed coincidences between the occurrence of the two phenomena would be 0.01, and if thunderstorms and the nocturnal ionisation were unrelated the corresponding probability would be 0.0015."

RADIO OBSERVATIONS OF THE BUREAU OF STANDARDS DURING THE SOLAR ECLIPSE OF AUGUST 31ST, 1932 [E-Layer Ionisation decreased to 30% of Normal, F_1-Layer to 40%, at Eclipse Maximum: No Appreciable Change in F_2 Critical Frequency (Absorption the Determining Factor ?): etc.].—S. S. Kirby, L. V. Berkner, T. R. Gilliland and K. A. Norton. (*Bur. of Stds. Journ. of Res.*, December, 1933, Vol. 11, No. 6, pp. 829–845.)

With regard to the lack of appreciable change in the F_2 critical frequency the writers mention that Kirby, Berkner and Stuart have shown that this frequency does not follow the normal characteristics of the lower layers (1933 Abstracts, pp. 438–439: the full paper will appear in the January issue of the *Journal*). "The possibility that this critical frequency does not indicate a maximum ionisation has been discussed, and it has been suggested that the determining factor is absorption rather than ionisation. It appears that the observed facts can be explained on this basis. It is possible that recombination occurred in the F_2 layer in the same manner as in the lower layers, but that such changes did not directly affect the critical frequency."

ELEKTROMAGNETISCHE ECHOLOTUNG DER IONOSPHÄRE (Electromagnetic Echo Sounding of the Ionosphere: A Film of the Kennelly-Heaviside Layer [Tromsö Polar Year Expedition]).—W. Fehr: Wagner. (*Funktech. Monatshefte*, December, 1933, No. 12, pp. 465–468.) Based on Wagner's address to the Heinrich-Hertz Institute.

LE CHAMP ÉLECTROMAGNÉTIQUE À DISTANCE : ONDES COURTES (The Electromagnetic Field at a Distance : Short Waves [Short Outline of Heaviside Layer Theory and Researches]). —(*Ann. des P.T.T.*, December, 1933, Vol. 22, No. 12, pp. 1082–1092.)

ULTRA-SHORT RADIO WAVES : REFRACTION IN THE LOWER ATMOSPHERE [due to Variation of Density of Air with Altitude, giving Concave Path of Radius about Six Times that of Earth : Comparison with Recent Experimental Results].—R. L. Smith-Rose and J. S. McPetrie. (*Wireless Engineer*, January, 1934, Vol. 11, No. 124, pp. 3–11.)

"The experimental work . . . summarised in Section III above makes it desirable to reconsider the problem, and particularly to investigate the paths of waves which start off at angles of less than 2° above the earth's surface and travel through the lower regions of the atmosphere at heights of only one or two kilometres." The calculation given in the Appendix, and the table on p. 7, indicate that refraction would produce a concave path of radius *m* times that of the earth, where *m* is likely to range from 5.8 to 6.7 according to the height of the path (0–2 000 metres); the Hawaiian Islands tests and Marconi's experiments require a value of $m = 2$ if they are to be explained by refraction alone. "A possible explanation of this apparent discrepancy might be found in the contribution which diffraction effects might make to the received signal intensity": moreover, if the received signals were due, in equal proportions, to waves arriving by diffraction and refraction, the fading met with in some of the experiments could easily be explained by a phase change of the latter relative to the former (produced, *e.g.*, by convection currents causing a variation in the refractive index). The diffraction of electric waves around the earth has been studied by Watson (*Proc. Roy. Soc.*, 1919) "but the subject may need further consideration in the light of modern experimental data obtained on ultra-short wavelengths."

INTERACTION OF RADIO WAVES [in the Propagating Medium : New Observations].—(*World-Radio*, 26th Jan., 1934, Vol. 18, No. 444, p. 132.)

Stuttgart on 533 m was received in the N. of England with a faint superposition of the Radio-Kootwijk programme on 1 875 m : the receiver was highly selective. The two stations lie in a straight line with the N. of England, and the writer suggests that the only explanation is the direct modulation of one wave by the other. The interference is not audible in daylight, so that the modulation may take place during the reflection of the indirect rays. *See* Tellegen, 1933 Abstracts, p. 558, l-h column.

REMARKABLE OPTICAL PROPERTIES OF THE ALKALI METALS [Critical Frequency on Exactly Same Basis as for Ionosphere].—C. Zener. (*Nature*, 23rd Dec., 1933, Vol. 132, p. 968.)

The electrons are treated as free, and the time between collisions of the electrons with the metallic lattice is assumed to be greater than the period of oscillation of the electric field.

TRASMISSIONI ELETTRICHE NON DISTORTE SU LINEE DISUNIFORMI (Undistorted Electrical Transmission along Non-Uniform Lines [and a New Treatment of Propagation along Lines]). —C. Laget. (*Alta Frequenza*, October, 1933, Vol. 2, No. 4, pp. 500–515 : Editorial p. 497.)

Author's summary :—The known equations of transmission are transformed by reducing them into a form which lends itself to a new physical interpretation of the phenomenon of propagation along lines. This interpretation consists in representing the phenomenon as due, in general, to the superposition of two "principal waves" which propagate in two directions with a speed of $1/\sqrt{LC}$ and are continually undergoing a partial attenuation and a partial reflection. Besides the physical interpretation, the analytical treatment acquires certain advantages from the new form given to the equations of the system.

In particular, the conditions are established which must obtain in order that a non-uniform line may be distortionless for a determined direction of propagation ; some examples of such lines are given. Finally it is shown that distortionless transmission can be obtained in both directions through non-uniform lines.

TAPERED LOADED SUBMARINE CABLE [Calculation of Propagation Constants].—A. T. Starr. (*Phil. Mag.*, January, 1934, Series 7, Vol. 17, No. 110, pp. 83–96.) *See* also Abstracts, 1933, p. 31, r-h column, and February, p. 86, r-h column.

SOME EXPERIMENTS DEMONSTRATING THE DIFFRACTION OF LIGHT BY SUPERSONIC WAVES.—R. Bär. (*Helvetica Physica Acta*, Fasc. 8, Vol. 6, 1933, pp. 570–580.)

ON THE ARTIFICIAL VIBRATIONS OF GROUND.—S. K. Banerji and M. D. Manohar. (*Indian Journ. of Phys.*, Part II, Vol. 8, 1933, pp. 95–121.)

ATMOSPHERICS AND ATMOSPHERIC ELECTRICITY

PROGRESSIVE LIGHTNING [Analysis of Photographs taken with the Boys Camera].—B. F. J. Schonland and H. Collens : C. V. Boys. (*Electrician*, 19th Jan., 1934, Vol. 112, No. 3, p. 69.)

Summary of Royal Society paper : a preliminary announcement was dealt with in 1933 Abstracts, p. 616. "The majority of the strokes were found to be double and to consist of a dart-like downward-moving leader stroke, followed immediately upon arrival at the ground by a more intense flame-like upward-moving main stroke. The mean velocity found for the leader strokes was 1.1×10^9 cm/s along the tortuous track in two dimensions, and 7.0×10^8 cm/s in the vertical direction. The length of the dart was found to be less than 54 metres. Corresponding mean velocities for the main strokes were 6.0×10^9 and 3.8×10^9 cm/s. The majority of the strokes were unbranched. Four strongly branched tracks have been examined. The branches always developed outwards from the main channel after the discharge had reached the branching point. The leader strokes are shown to be identifiable with electron avalanches and the main strokes with thermally ionised channels. The polarity of the discharges was such as to make the cloud-base negative and the earth positive."

The Lightning Stroke: Some Theoretical Speculations [including the Existence of Four Stages, the Value of the Surge Impedance, etc.].—L. V. Bewley. (*Gen. Elec. Review*, December, 1933, Vol. 36, No. 12, pp. 516–523.)

The first stage is that covered by Simpson's theory of the formation and charging of a thundercloud: the second comprises the local discharge between adjacent regions in the cloud: the third involves the formation of the main discharge channel to earth (having the properties of a surge impedance) and the penetration of the cloud mass by ionised streamers. The fourth stage follows the elimination of the surge impedance and the completion of the discharge paths in the cloud mass: during this final period the discharge is probably similar to that of a distributed capacitance network: it is essentially exponential in character. When the voltage across the main stroke falls so low that the arc can no longer be maintained, the latter breaks, but retains its ionisation for a comparatively long time and may be re-struck by the capacitance network equalising its potential to its average value when the arc was quenched.

The surge impedance depends on the diameter of the stroke and the mean diameter of the electrostatic field of the cloud to earth. Its numerical value, however, is not sensitive to variations in these dimensions and for all practical purposes may be taken as 400 ohms. It has not yet been definitely proved that the main channel proceeds from earth to cloud rather than conversely, but there is a 2 : 1 difference in the amplitude of the initial wave in the stroke, depending on which is the case. Regarding the cloud as a huge metallic capacitor discharging through the surge impedance of the main channel "leads to ridiculous results not borne out by field observations and measurements."

Some Studies on the Antenna-Earth Current [Investigations of the Electrical Field under a Thundercloud].—H. Noto. (*Proc. Phys.-Math. Soc. Japan*, 1929, Vol. 7, p. 1 : 1931, Vol. 8, p. 18[illegible] and 1933, Vol. 15, pp. 238–245.)

The Branching of Lightning and the Polarity of Thunderclouds.—J. C. Jensen. (*Journ. Franklin Inst.*, December, 1933, Vol. 216, No. 6, pp. 707–748.)

Previous work by the writer has been referred to in Abstracts, 1928, p. 223, and 1932, p. 519. The present paper gives a study of problems relative to the polarity of thunderclouds and the direction of field change resulting from a given lightning discharge. The findings of Schonland (Abstracts, 1928, p. 684, and 1932, p. 91), Halliday (1933, p. 32 : *see* also pp. 208–209) and others regarding the direction of branching are corroborated. A ratio of 1 negative field change to 1.71 positive field changes is found, in substantial agreement with Wilson's ratio of 1 : 1.56. "The larger number of field changes of positive sign is accounted for by the larger area of negative cloud in a horizontal cross-section than of positive cloud. The meteorological and electrical data of these experiments are shown to be in general agreement with a storm of the type described by Banerji (1931, pp. 33–34, and 1933, p. 32) with a concentration of negative charge in the front portion."

A Study of Lightning and Hail.—C. Dauzère. (*Bull. de la Soc. d'Encouragement pour l'Industrie nationale*, October, 1933, Vol. 132, pp. 505–528.)

Lightning Measured on 4-kV Overhead Circuits [Chicago Results during past Four Years].—H. Halperin and K. B. McEachron. (*Elec. Engineering*, January, 1934, Vol. 53, No. 1, pp. 33–37.)

Heavy Surge Currents—Generation and Measurement [up to more than 100 000 Amperes: Effective Durations greater than 100 Microseconds].—P. L. Bellaschi. (*Elec. Engineering*, January, 1934, Vol. 53, No. 1, pp. 86–94.)

Study on Surface Discharges under the Influence of Damped High-Frequency Currents [Influence of Frequency on Development of the "Gleitbüschel": etc.]. Y. Asami and T. Katayama. (*Journ. I.E.E. Japan*, November, 1933, Vol. 53 [No. 11], No. 544, pp. 1000–1006: English summary pp. 94–96.)

A Study of the Evaporation of Small Water Drops.—H. G. Houghton. (*Physics*, December, 1933, Vol. 4, No. 12, pp. 419–424.)

Condensation of Water in the Atmosphere [Synopsis of British Association Papers]. (*Nature*, 16th Dec., 1933, Vol. 132, p. 938.)

Ionen oder Ionenpaare? (Ions or Ion Pairs? [Indiscriminate Use of "*N*" to represent Either]).—W. Braunbek. (*Physik. Ber.*, 15th Dec., 1933, Vol. 14, No. 24, p. 1992.)

Some Earth Potential Measurements being made in connection with the International Polar Year.—G. C. Southworth. (*Proc. Inst. Rad. Eng.*, December, 1933, Vol. 21, No. 12, pp. 1740–1748.)

"It is expected that useful correlation will be found between the normal earth potential effects which occur day after day during undisturbed periods and the corresponding diurnal and seasonal variation of radio transmission. It seems entirely probable, for instance, that earth potentials are but the terrestrial manifestations of certain changes taking place in the Kennelly-Heaviside layer which may not be found by other methods. This paper is intended to serve mainly as a progress report outlining briefly the methods and scope of the work and showing the type of data being obtained [in New York, Maine, Illinois and other states]. It leaves to a later date most of their correlation and their interpretation. . . . We might conclude, tentatively at least, from the data above, that the eastern mountain ranges exhibit higher conductivity longitudinally than transversely. We might, consequently, expect less attenuation to broadcast transmission in a north-east/south-west direction than along its perpendicular. It would be interesting to know whether such a difference has ever been observed." For earth potential disturbances, as contrasted with the normal effects, " the tendency near New York for the voltage to be directed along a north-west/south-east line, so conspicuous above for the normal diurnal variation, holds also for this abnormal or disturbed period. It would also appear that the relative magnitudes measured at these various points are related to local conditions in much the same manner as for the normal effect."

EXPERIMENTS IN THE STRATOSPHERE [Comments on Proposed Balloon Ascents].—(*Nature*, 6th Jan., 1934, Vol. 133, pp. 15–16.)

ANCIENT RECORDS OF SUNSPOTS AND AURORAS IN THE FAR EAST, AND THE VARIATION OF THE PERIOD OF SOLAR ACTIVITY.—S. Kanda. (*Physik. Ber.*, 1st Dec., 1933, Vol. 14, No. 23, p. 1982.)

THE MAGNETIC OBSERVATORY OF THE ROYAL NAVAL HYDROGRAPHIC INSTITUTE, GENOA [including Tables of Polar Year Results].—M. Tenani. (*La Ricerca Scientifica*, 30th Nov., 1933, 4th Year, Vol. 2, No. 10, Supp. pp. 70–78.)

SOURCES OF ATMOSPHERICS AND PENETRATING RADIATION.—E. V. Appleton and E. G. Bowen. (*Nature*, 23rd Dec., 1933, Vol. 132, p. 965.)

This letter describes simultaneous directional observations of the arrival of atmospherics and of penetrating radiation, using a wireless cathode-ray direction finder and a pair of Geiger-Müller counters, arranged to receive particles coming from an easterly direction. The number of coincidences between the arrivals of atmospherics and penetrating radiation is found to be no greater than would be expected from a chance distribution. The rate of incidence of atmospherics in the two seconds immediately following the arrival of penetrating radiation is definitely in excess of the mean rate, and the results support those of Schonland and Viljoen (1933 Abstracts, p. 442, l-h col.) and the " runaway electron " theory of C. T. R. Wilson.

COSMIC ACTIVITY AND SOLAR ACTIVITY. OBSERVATION OF THE COSMIC RAYS AT SCORESBY SOUND DURING THE POLAR YEAR.—A. Dauvillier. (*Comptes Rendus*, 26th Dec., 1933, Vol. 197, No. 26, pp. 1741–1744.)

For the writer's Notes on polar auroras and ozone *see* Abstracts, January, pp. 31–32, and February, p. 87, l-h col. In his theoretical interpretation of the observations now discussed he says : " In the theory we have given of the origin of the cosmic rays (1931, p. 609) the solar electrons, issuing from granulations and faculae, are accelerated in the electrical field, weak but of large extent, reigning in the chromosphere. They form the solar corona, then the zodiacal light magnetising the earth. They finally spiral in the magnetic field of the globe and escape after traversing the upper atmosphere. The secondary electrons emitted are responsible for the polar and non-polar auroras and their secondary effects (telluric currents, ozone, etc.). The photons emitted constitute the cosmic rays.

" We have proved recently that the phenomena varying with the solar activity (polar auroras, magnetism, tellurism, etc.) were due to the fine coronal jets given out by the faculae and constituting the *outer* equatorial corona. The almost constant phenomena, following only to an inappreciable extent the activity of the sun, such as the zodiacal light and the cosmic rays, must be connected with the *inner* equatorial corona. Photometric measurements of the global intensity of the corona during eclipses show a remarkable constancy, independent of solar activity. The jets associated with the faculae have, then, only a weak relative intensity and owe their activity on our globe either to their density or rather to their energy, no doubt rather superior to that of the elementary jets issuing from the granulations, forming the inner corona. The former, accidental, would thus be capable of a closer approach to the poles (as far as an earth's radius), penetrating more deeply into the earth's atmosphere and producing in it effects which are intense *locally* (polar auroras). The second type of jet [from the inner equatorial corona], much more numerous and constant but more easily deviated, only traverse the atmosphere at a distance of from 1 to 6.6 earth's radii. The source of the cosmic rays is thus of slight density but of very great volume, practically constant and independent of the solar activity."

MEASUREMENTS OF COSMIC RAYS ON MT. ROCCIAMELONE [at Heights up to 3 537 Metres : Absorption Coefficients in 5 Centimetres of Iron].—G. B. Rizzo. (*Physik. Ber.*, 15th Nov., 1933, Vol. 14, No. 22, p. 1898.)

THE RESULTS OF THE SCIENTIFIC MISSION TO ERITREA FOR THE STUDY OF THE COSMIC RAYS [Preliminary Communication].—B. Rossi. (*La Ricerca Scientifica*, 30th Nov., 1933, 4th Year, Vol. 2, No. 10, pp. 365–368.)

REMARKS ON DISINTEGRATION OF ATOMS BY COSMIC RADIATION.—J. Barnóthy : Steinke. (*Zeitschr. f. Physik*, 1933, Vol. 85, No. 3/4, pp. 201–209.) For Steinke's comments see *ibid.*, pp. 210–211.

COSMIC RAYS AND NUCLEAR PHYSICS.—R. A. Millikan. (*Nature*, 14th Oct., 1933, Vol. 132, p. 612.)

NEUTRONS FROM COSMIC-RAY IMPACTS.—G. L. Locher. (*Phys. Review*, 1st Nov., 1933, Series 2, Vol. 44, No. 9, pp. 779–781.)

DISTRIBUTION OF COSMIC-RAY NUCLEAR DISINTEGRATION IN TIME.—C. G. and D. D. Montgomery. (*Phys. Review*, 1st Nov., 1933, Series 2, Vol. 44, No. 9, p. 779.)

ON THE PRESENCE OF NEUTRONS IN COSMIC RAYS.—P. Auger and G. Monod-Herzen. (*Comptes Rendus*, 4th Dec., 1933, Vol. 197, No. 23, pp. 1406–1407.)

PAPERS ON THE DEPENDENCE ON PRESSURE OF THE RESIDUAL IONISATION IN MEASUREMENTS OF COSMIC RADIATION.—Pfundt: Körner: Priebsch. (*Zeitschr. f. Physik*, 1933, Vol. 85, No. 7/8, pp. 439–450.)

AN IMPROVED COSMIC-RAY METER.—A. H. Compton. (*Review Scient. Instr.*, September, 1933, Vol. 4, No. 9, pp. 491–495.)

PROPERTIES OF CIRCUITS

SULLA RESISTENZA EQUIVALENTE DI ENTRATA DI UN TRIODO DEMODULATORE PER GRIGLIA (On the Equivalent Entrance Resistance of a Triode giving Leaky-Grid Detection).—E. Severini. (*Alta Frequenza*, October, 1933, Vol. 2, No. 4, pp. 537–547: Editorial pp. 498–499.)

Author's summary:—A valve giving leaky-grid detection produces, in the oscillatory circuit preceding it, a loss of energy the knowledge of which is of great importance, since on it depends some of the essential characteristics of the circuit. The loss caused by the valve is generally evaluated as an "equivalent entrance resistance." For the calculation of this resistance certain formulae have been proposed by other writers which, however, when subjected to the present experimental checking, have not been found satisfactory.

The writer describes the apparatus and method of measurement adopted for the determination of the equivalent resistance and, on the basis of the results obtained, brings into prominence certain factors which, though exerting a marked influence on the results, are neglected in the formulae [*e.g.* the mode of variation of the entrance resistance with the voltage induced in the oscillatory circuit]. Finally, attention is drawn to the principles to which the designer of radio receivers should conform in calculating the oscillatory circuit preceding the detector [taking into account the above-mentioned resistance variation with the signal strength].

HOW SHOULD THE WORKING CHARACTERISTICS OF PHASE-TRUE ANODE RESISTANCES BE USED IN ORDER TO HOLD GOOD FOR ANY COMPLEX ANODE RESISTANCE?—E. Grünwald. (*T.F.T.*, December, 1933, Vol. 22, No. 12, pp. 306–308.)

"The valve data and the generally complex resistance of the external anode circuit are assumed to be known: it is required to find the relationship between grid potential and anode current in the characteristic curve-field. The writer shows how a phase-true equivalent resistance may be found so that the working characteristic of this may give the solution required."

ÜBER EINSCHWINGVORGÄNGE BEI TRANSFORMATORVERSTÄRKERN. II. TEIL. MEHRSTUFIGE VERSTÄRKER (Transients in Transformer-Coupled Amplifiers. Part II. Multi-Stage Amplifiers).—W. Nowotny. (*Archiv für Elektrot.*, 8th Dec., 1933, Vol. 27, No. 12, pp. 832–848.)

Part I, dealing with a single-stage amplifier, was referred to in Abstracts, 1933, p. 340, l-h col. The present paper begins by pointing out that the theory of multi-stage amplifiers is, apart from approximate solutions, very complicated even for the stationary condition. As a result of the frequency-dependent complex anode resistances, the input resistances of the valves and consequently, with transformer coupling, the secondary loads of the transformers are here neither constant nor purely capacitive; strictly speaking, all the stages of the amplifier chain mutually affect each other. These complex phenomena have been investigated by Feldtkeller and Strecker for the built-up condition (1931, pp. 92–93).

In the present paper the writer deals with the building-up processes, neglecting for the sake of simplicity the variable loading of the transformers through the input resistances of the valves, and assuming that the transformers are loaded with constant capacities of some mean value, and that the valves function without retroactive coupling through the anode/grid capacity: these assumptions are shown by the experimental check to be permissible. It follows that the radical function of the whole amplifier (the ratio of the input potential to the output potential) is equal to the product of the radical functions of the individual stages. Consequently the transmission angle of the chain is equal to the sum of the transmission angles of the stages. This same simple addition naturally holds good for the derivative of the transmission angle with respect to frequency, $da/d\omega$, and thus for the building-up period calculated from the group transit time by neglecting the amplitude distortion. Since, however, it was shown in Part I that, in addition to phase distortion, amplitude distortion is of very great importance for the case under consideration, the writer takes into account both types of distortion in his calculation of the transient times by means of the Heaviside formulae extended by Wagner.

The transient functions for n equal stages are found for direct transformer coupling (Fig. 1) and also the building-up times (Fig. 2: curve a for low, curve b for high frequencies). The resistance-transformer coupling (with blocking condenser in the primary circuit of the transformer, to prevent loss of inductance through d.c. magnetisation) is also investigated: here the equilibrating (transient) effect for one stage is made up of a damped oscillation of about the resonance frequency of the primary circuit and one of about the leakage resonance frequency (or, for aperiodic cases, of two additional components decreasing comparatively quickly with time in an exponential fashion).

The building-up times for a single-stage resistance-transformer coupling are shown in Fig. 3; for two equal stages the building-up period increases to 1.7 times that of the single stage. As regards resistance-coupled amplifiers, somewhat simpler but quite analogous formulae hold good as for the direct transformer coupling: Figs. 1 and 2 again apply. But with resistance coupling the upper limiting frequency generally lies much higher than with transformer coupling (owing to transformer capacity), the transient function rises more sharply, and the building-up times for high frequencies are smaller. The writer asserts that the differing results obtained by Schlesinger (Abstracts, 1932, pp. 32–33 and 33) were due to a mistake in sign, leading to the conclusion that the transient function would not change its sign for several stages but would sink steadily to zero after reaching a maximum. The writer gives an oscillogram showing the change of sign: Schlesinger's oscillograms fail to show it because the time deflection was chosen too high.

The writer then considers the case where the various stages differ among themselves: the transient process is then conditioned by the stage which has the greatest variation with frequency. The final section 7 (followed by two appendices) gives oscillograms of characteristic cases—resistance-transformer coupling, resistance amplifier, and multi-stage transformer-coupled amplifier. With regard to the last named, the writer refers to Lane's paper on the resistance-capacitance coupled amplifier in television (1932, p. 415) leading, by operational methods, to a result which agrees with the writer's more generalised investigation.

THE BEHAVIOUR OF THE RESISTANCE-CAPACITY-COUPLED AMPLIFIER TO SWITCHING [Transient] PROCESSES.—Kroker and Felgentreu. (*See* under "Phototelegraphy and Television.")

GLEICHRICHTUNG (Rectification and Detection).—M. J. O. Strutt. (*Hochf:tech. u. Elek:akus.*, December, 1933, Vol. 42, No. 6, pp. 206–208.)

The writer considers the important case of a voltage source of internal resistance r acting on an impedance Z in series with a rectifier E. The characteristic of the latter (d.c. current i plotted against d.c. voltage v from a source practically free from internal resistance) is assumed to be known. What is required to be found is the voltage at the ends of Z for a given voltage or power of the source, r being known. If the rectifier characteristic is represented by $i = F(v)$ . . . . (1), the current i through Z for any voltage V of the source is given by the formula $i = F(V - ir - iZ)$ . . . . (2). This fundamental formula of rectification theory is obviously a complex functional equation. It is here dealt with in the case represented by

$V = E_i \cos x + E_h \cos y\,;\ x = \omega_i t\,;\ y = \omega_h t$ . . . . (3).

The current i will be a complex function of t, and can be expanded into a Fourier series

$i = \Sigma\Sigma\{i_{\pm m,n} \cos(mx \pm ny) + i_{\pm m,n} \sin(mx \pm ny)\}$ (4).

The angular frequencies of the various components of i can be put in the form

$\omega_{m,n} = m\omega_i \pm n\omega_h,\quad m, n = 0, 1, 2$ . . . . . (5)

The impedance Z is a function of the frequency. Equation (2) is readily solved for small potentials V (and E_i and E_h). In this case equation (1) can be developed into a Taylor series. The solution is obtained by equating the corresponding terms on the right and left of (2).

The static rectification characteristic (1) is approximated by a (finite) sum of powers of (exponential) e, thus: $i = \Sigma A_n e^{a_n V}$. Figs. 2 and 3 show that this summation actually gives a useful representation of the actual behaviour of a rectifier: the curve is calculated, the points show the measured characteristic. With the help of this approximation the formula (6), involving Bessel functions, can be made to yield all the Fourier coefficients of the resulting alternating current, so that the wanted and unwanted (distorting) current components can be determined. The practical value of this approximate formula for the static rectification characteristic is twofold: in the first place it allows the dynamic working of the rectifier to be calculated with great accuracy from the measured static characteristic, without further measurements; and in the second place, since it can be made to hold exactly by the inclusion of a sufficient number of terms, conclusions of general validity can be drawn from it as regards the functioning of rectifiers. Thus in section III the simplest case, that of a single impressed a.c. frequency, is dealt with, while section IV considers the important case of two impressed a.c. potentials of different frequencies. This last investigation includes the special case, of great practical importance, where Z possesses a finite value R for one definite frequency only, being vanishingly small at all other frequencies and for d.c.

In his final section the writer refers to Bennett's paper on modulation products (1933 Abstracts, p. 389) in which somewhat analogous calculations occur; these, however, relate only to another case of the rectification problem, the characteristic of the rectifier being taken as rectilinear. The two methods of treatment are compared. The writer concludes by announcing that the practical application of the above work will be dealt with in a paper "On Conversion Detectors" to be published elsewhere.

SPANNUNGEN, WIDERSTÄNDE UND ABSTIMMUNG IN EINEM FREISCHWINGENDEN SYSTEM VON MITEINANDER FESTGEKOPPELTEN KREISEN (Potentials, Resistances and Tuning in a Freely Oscillating System of Circuits Tightly Coupled to Each Other).—M. Osnos. (*Hochf:tech. u. Elek:akus.*, December, 1933, Vol. 42, No. 6, pp. 202–205.)

In previous papers (Abstracts, 1932, p. 457; 1933, p. 97) the writer dealt with a single freely oscillating system. His treatment is now extended to a system composed of any number of freely oscillating L, C, R circuits coupled together, and it is shown that if L, C and R in these circuits are changed in any way the natural frequency of the system so adjusts itself that the sum of all the idle resistances (and idle potentials) of the individual circuits of the system, for that frequency, is zero at any moment; the same law holds good for the energy components.

By idle potential ("Leerspannung") is meant a potential 90° out of phase with its corresponding current, and by idle resistance the ratio of the instantaneous value of an idle potential to the instantaneous value of its corresponding current.

CHARACTERISTICS OF RESISTANCE AND REACTANCE OF A VARIOMETER CONSISTING OF TWO CIRCUITS IN PARALLEL.—C. Chiodi. (*L'Elettrotec.*, 25th Dec., 1933, Vol. 20, No. 36, pp. 859–861.)

OVERTONES AND FUNDAMENTAL PERIOD OF AN ELECTRIC OSCILLATORY CIRCUIT.—E. Hallén. (*Phil. Mag.*, January, 1934, Series 7, Vol. 17, No. 110, pp. 192–197.)

This note describes an experimental verification of a formula deduced by the writer for the free periods of a circuit consisting of a capacity and a coil inductance of one layer of turns.

TRANSMISSION

ELEKTRONEN- UND IONEN-TANZ-SCHWINGUNGEN IM MAGNETRON ("Electron- and Ion-Dance" Oscillations in the Magnetron).—T. Mulert. (*Hochf:tech. u. Elek:akus.*, December, 1933, Vol. 42, No. 6, pp. 194–201.)

Author's summary:—(1) Various methods of investigating "electron-dance" oscillations are given ["hitherto . . . a Lecher system with detector or thermojunction, or some similar tuneable resonance circuit, has been used. It has been found that an ordinary, well calibrated short-wave receiver can well be used as an extraordinarily sensitive heterodyne wavemeter for wavelengths down to about 80 cm: with large amounts of oscillating energy still shorter waves can be measured. The audion must deliver as many harmonics as possible: these are superposed on the oscillations to be measured and after detection are audible in the receiver output circuit. The method enables one to determine very quickly if any change in the working conditions shortens or lengthens the wave. . . . Difficulties arise in the investigation of a frequency mixture, when the high sensitivity gives a great number of points of heterodyne signals. . . . Oscillations inside a valve can also be indicated by measuring the internal resistance R_i with alternating current: the onset of oscillation produces more or less marked discontinuities in the previously smooth course of the R_i-curve, which can be regarded as directly characteristic of the oscillations. These irregular curves (Fig. 1) are completely reproduceable except for small variations of the absolute heights. A special method for the detection of oscillation in the magnetron is also provided by the plotting, with alternating current in the circuit shown in Fig. 2, of mutual conductance curves, which reveal the fine structure of the magnetron characteristic. . . . In both of these last two methods the resistance in the anode circuit has to be varied, which causes changes, in general slight, of the oscillating conditions, so that the measurements give no quantitative conclusions without the introduction of measuring apparatus. Finally, electrodes—grids or single wires—introduced into the valve and given a negative potential can be used as exploring electrodes for the detection of oscillations: at the onset of oscillation a building-up current sets in against the negative bias of the exploring electrode, and can easily be detected by a sensitive galvanometer"].

(2) It is found that after the critical field strength is passed the magnetron oscillates continuously and that the oscillations are often strongly modulated. This modulation is traced to the "dance of the ions." (3) This ion dance is investigated in the absence of the magnetic field. In diodes and triodes without any attached oscillatory circuits it was found that oscillations occur of wavelengths from a hundred or so to a thousand metres [at the transition from space charge to saturation: "their oscillation-form and frequency may vary very much with working conditions. . . . For the explanation of this oscillation process further investigations are necessary"]. (4) The influence of the ionic oscillations on the magnetron is discussed; the increase of oscillatory energy produced by slanting the magnetic field is explained by a decrease of the ionic oscillations and a consequent more nearly sinusoidal wave-form for the electronic oscillations.

(5) The electronic oscillations are considered as space-charge oscillations ["the departures of the wavelengths from the calculated values, found by previous investigators, all combined to show that with low anode voltages the observed wavelengths were too long, while increased anode voltage gave better agreement." This would be explained by the greater space charges at the low anode voltages: confirmation is found in the fact that, with all the valves experimented with, if the heating was decreased during strong oscillation a marked falling-off of energy occurred, which could be abolished by increasing the magnetic field and with it the space charge].

(6) The extraction of energy [transference to the load circuit] is dealt with and an inductive coupling investigated ["in the literature only capacitive coupling is considered. . . . Lecher systems between cathode and anode or between the two halves of an anode split in two places." The writer, prompted by O. Schmidt, has experimented with an inductive coupling made by slitting the cylindrical anode by one longitudinal cut and joining the Lecher system to the edges of the slit, so that the one-turn winding formed by the anode serves as an inductive coupling to the oscillating electrons. This device acted very successfully: by matching the Lecher system accurately with the anode impedance the retroaction could be made so strong that the oscillations broke off].

(7) Two methods of measuring the energy are tested [incandescent lamp, and a winding containing a thermo-junction coupled inductively to the bridge of the Lecher system]. It was found that about 20% of the anode d.c. energy was transformed into r.f. energy. (8) The increase of filament brightness on the onset of oscillation is explained by electronic bombardment [Hollmann's explanation by positive ion bombardment only holds for a valve with a poor vacuum]. A r.f. loss of at least 10% of the anode d.c. energy is thus caused. (9) An exploring electrode method is described which allows the r.f. potentials inside the valve to be determined. The maximum r.f. potential amounts to about 35–40% of the anode d.c. potential.

EINE VERBESSERTE SYMMETRIESCHALTUNG ZUR ERZEUGUNG ULTRAKURZER WELLEN MITTELS FREMDGEHEIZTER SENDERÖHREN (An Improved Symmetrical Circuit for Ultra-Short-Wave Generation with Indirectly Heated Transmitting Valves [and Description and Data of Telefunken Valves RS 282, 270 and 272]).—R. Elsner. (*Funktech. Monatshefte*, December, 1933, No. 12, pp. 477–481.)

Even in the simple capacitively coupled push-pull generator as used by Esau with directly heated valves there is already the defect of the small dynamic resistance of the oscillatory circuit, due to the unfavourable L/C ratio and causing under-voltaged working and the loss of much of the energy in the form of heat at the anode. But if indirectly heated valves are tried in this circuit, two more defects appear: the leads to the emission electrodes have so little impedance that a large enough potential drop for the production of a strong a.c. potential on the grids cannot be obtained (hence once more an under-voltaged condition), and the unavoidable capacity between emission electrodes and heating filaments cause further losses which increase with the frequency. "All these additional objections to the use of indirectly heated valves, in place of directly heated, are avoided if the emission circuit is made in the form of a tuneable oscillatory circuit, the cathodes being connected either in a single-ended or in a double-ended fashion: in practice this means either a parallel connection of the tuning condenser with regard to the lead joining one end of each cathode, or else a series connection" [the two cathodes in series with each other and with the condenser].

By thus tuning the emission circuit roughly to the generator frequency, the dynamic resistance of the whole oscillator circuit is increased, the unwanted r.f. potential differences in the heating circuit (due to the cathode/filament capacities) are avoided, the mid-point tapping of the lead connecting the cathodes becomes the true zero-potential point of the whole oscillator (increasing the output and efficiency and also preventing the excitation of false frequencies) and the working of the oscillator is simplified, since the wave-traps in the heating leads can be abolished now that the heating circuit is de-coupled from the emission circuit. The final practical diagram of connections is seen in Fig. 6, and in semi-perspective in Fig. 7 (for a valve where the important r.f. electrodes are brought out at the top, "as is essential for wavelengths of 3 m and under"). Fig. 8 shows the sharp peak in the r.f. output/emission-circuit-tuning curve for a wave of 1.46 m, contrasted with the small effect for a 5.70 m wave: this difference is discussed and explained.

The final section gives reasons for the use of indirectly heated valves. "One of the chief reasons for the unsuitability of commercial directly heated single-grid valves for the production of ultra-short waves (1.20–5 m), apart from the usually far too great internal capacities and the consequent under-voltaged working conditions, is the no longer phase-true retroaction coupling factor, which is dependent on the internal resistance and can only be raised by decreasing the latter. But for a dimensioning of the valve controlled by other circumstances such a decrease of internal resistance, for better matching with the dynamic resistance of the external elements, demands an increase of slope; the only way to do this, unless the heating power is to be increased, is to employ the indirectly heated oxide-coated cathode."

Electron Oscillations with a Triple-Grid Valve [Ultra-Short Waves around 1.5 Metres: B-K and G-M Types: Frequency independent of Potential of One Grid and Amplitude practically proportional to this Potential (suggesting Method of Modulation): Less Overloading than with Triodes].—F. Hamburger, Jr. (*Proc. Inst. Rad. Eng.*, January, 1934, Vol. 22, No. 1, pp. 79–88.)

Ultra-Short-Wave Generating Circuit having All the Inductance of Grid and Retroaction Circuits in the Spirally Wound Grid and Anode.—A. B. Du Mont: De Forest Company. (U.S.A. Pat. 1 915 356, pub. 27.6.1933: *Hochf:tech. u. Elek:akus.*, December, 1933, Vol. 42, No. 6, p. 218.)

Note on the Theory of the Magnetron Oscillator [Okabe's Formula $\lambda H = 10\,650$ and Its Modification to allow for Space Charge Effect].—E. C. S. Megaw: Hoag. (*Proc. Inst. Rad. Eng.*, December, 1933, Vol. 21, No. 12, pp. 1749–1751.)

Referring to Hoag's note (Abstracts, 1933, p. 620, l-h col.) Megaw quotes the formula for the transit time in a cylindrical magnetron given in his own paper (1933, p. 324, l-h col.) from which are obtained the relations $\lambda H = 12\,300$ (zero space charge) and $\lambda H = 16\,700$ (saturated space charge) for anode-radius/filament-radius ratios of the order of 100: Okabe's relation was obtained by assuming the filament radius to be infinitely small and the whole of the inter-electrode space to be at anode potential so that the electrons attain their maximum velocity directly they leave the filament. The writer's formulae agree well with the observed minimum and maximum wavelengths when the oscillation amplitude is small: the observed values tend to be slightly on the low side, especially when the field is inclined to the electrode axis: an explanation of this is suggested.

Theories on Frequency Stabilisations and Amplitude Variation of Dynatron-Type Oscillators [and the Erroneous Ideas as to the Chief Cause of Frequency Variations].—R. Usui. (*Journ. I.E.E. Japan*, November, 1933, Vol. 53 [No. 11], No. 544, pp. 1030–1036: English summary, pp. 102–104.)

This paper forms Part V of the writer's "Operating Mechanisms of Negative Resistance Oscillators" (Abstracts, 1933, p. 155). "Many authors have wrong ideas for frequency variations of dynatron oscillators. They consider that the term $\psi(x)$ [in the equation

$$x'' + af(x)x' + x\{1 + \psi(x)\} = 0]$$

is the chief cause" of the variations due to voltage changes. The writer obtains expressions for the elongation τ_2 of the oscillation period due to this term, for dynatron and tuned-plate triode oscillators respectively: from these it is clear that the only factors affecting the elongation due to this term are R, C and L. "Dr. Marc Bruzau also has this wrong idea, and he has deduced a series of analytical relations which eliminate the term $\psi(x)$ (in his paper this term is R/ρ) by inserting L of proper value in series with the source of negative resistance ρ, or by dividing L or R, or both of them, of the main inductance into two parts, and branching the source between them" (1933, pp. 109–110). The writer then finds an expression for the τ_1 part of the elongation of the period, which *is* responsible for the frequency variations, and studies the relation between the amplitudes and the values of τ_1, finding a condition in which "the oscillator will operate with very steady frequency and also with comparatively large amplitude." He gives approximate solutions of the stabilising effects found by Bruzau, but is obtaining further data for verifying the theoretical analysis.

A Note on Tests of the "Floating Carrier" Method [Power-Saving Method of Regulating Carrier Power to Amount of Modulation] **applied to a Broadcasting Transmitter.**—W. T. Ditcham. (*Marconi Review*, Nov./Dec., 1933, No. 45, pp. 1–2.)

Chelmsford tests to observers at distances from a few yards up to 800 miles indicate that the difference, if any, between the constant-carrier and "floating-carrier" methods is very slight, and on certain receivers certainly not detectable. The aerial power with the normal method was about 8 kw; with "floating-carrier" this was reduced to less than 2 kw in the absence of modulation.

Modulation Meter [Differential Instrument fed by Two Rectifier Circuits with Different Time Constants].—Terman. (*See* under "Measurements and Standards," pp. 162/3.)

Correlation of Theoretical and Experimental Data on Class C Operation of Radio-Frequency Amplifiers.—R. J. Davis and W. J. Cahill. (*Rad. Engineering*, December, 1933, Vol. 13, No. 12, pp. 12–14.)

Improving the Performance of the [Short-Wave] Neutralised Power Amplifier—Permanent Neutralisation—Higher Efficiency—Harmonic Suppression.—G. Grammer. (*QST*, January, 1934, Vol. 18, No. 1, pp. 27–31.)

RECEPTION

Das Gegentaktbremsaudion als Empfänger für Dezimeterwellen (The Push-Pull Brake-Field Audion as a Receiver for Decimeter [Micro-] Waves.).—H. E. Hollmann. (*Hochf:tech. u. Elek:akus.*, December, 1933, Vol. 42, No. 6, pp. 185–190.)

The writer's previous work (Abstracts, 1933, pp. 621 and 621–622) has already shown that in the brake-field (retarding-field) audion detector only the carrier potential on the brake-field electrode plays a part in the rectifying process, by the transference of the mirror image of the braking characteristic to the grid. Up to the present, however, in all the decimetre-wave receivers described the valve has had its brake-electrode and grid connected to the Lecher wires excited by the aerial, so that only that half of the resonance potential arriving on the brake-electrode was rectified, the component reaching the grid being lost. This defect can, it is true, be avoided by abandoning the use of a closed resonance system and, for instance, connecting the aerial direct to the brake-electrode (Carrara, 1933, p. 38: *see* also p. 503, and January, p. 33); but with such an arrangement it is never possible to obtain such large control potentials as are available across the wires of a closed Lecher system, and in particular a reduction of damping by "ultra-dynamic" excitation presents difficulties due to the indefinite retroaction conditions.

If, therefore, the Lecher system is to be retained, the obvious step to take in order to utilise the full resonance potentials for detection is to use two valves in push-pull, keeping each brake-electrode at a potential antinode of the closed Lecher system, as was already found advantageous (*loc. cit.*). Then if both valves function at similar working-points, such as the lower bend of their characteristics, the rectified currents will be of the same sign and the d.c. potentials on the grids will be in phase, so that the latter can be loaded with a common external resistance R_g (Fig. 1). Or, for an effective reduction of damping, the grids can be coupled together through a second tuneable oscillatory circuit (*cf.* Marconi, 1933, p. 267; *see* also p. 266, r-h column).

The next step is to combine the two valves into a single "push-pull brake-field valve." This can be done in two ways: the apparently simplest (Fig. 2a, where the cylindrical brake-electrode is divided into two short cylinders around a single grid and filament) actually involves the complication of different biasing values owing to the potential drop along the filament. This is avoided in Fig. 2b, where the brake-electrode is divided axially instead of radially. Fig. 3 shows such a valve in an appropriate circuit. Since the grid is controlled in push-pull by the two brake-electrode segments, it carries no radio frequency but only the l.f. modulation, so that it can be led out through the valve base, while the brake-electrode segments are brought out by low-capacity leads.

The modulating voltage $e \sin \omega t$ no longer lies between brake-electrode and grid, as in previous receivers, but between the two brake-electrode segments. An investigation of the static characteristics of these segments taken together (increasing the potential of one and reducing that of the other by an equal amount) shows that the inhomogeneity of the electrical field in the neighbourhood of the separating gap (Fig. 2b) produces current-transference phenomena (and an "ultra-dynamic" phase-displacement between current and potential) which may cause a negative resistance between the segments and a setting up of r.f. oscillation. If radial screens from the grid are introduced in the gaps between the segments (Fig. 7) the current transference is reduced but not abolished, and the unexpected result is found that the oscillations which still may set in are of longer wavelength than before. This effect is traced to the "penetration" of the segment potentials through the grid round the screens, giving a longer path and resulting in an almost treble increase of the "inversions constant" $\lambda^2 E_g$ from an average of 88×10^4 (wavelengths 63.5 to 150.5 cm.) to 257×10^4 (wavelengths 106 to 184 cm).

Receiving tests with the circuit of Fig. 3 showed a very high sensitivity compared with other "decimetre" receivers. A particularly striking point, however, was that the resonance tuning was not mainly determined by the position of the Lecher system bridge (as in ordinary brake-field circuits) but could be shifted over a comparatively wide wave-range by varying the grid potential, keeping the external tuning constant. This result naturally led to the plan of abandoning the Lecher system and connecting the two halves of the dipole aerial direct to the two segments of the brake-electrode (Fig. 8), tuning being accomplished by adjusting the grid potential by the potentiometer *P*, and damping reduction by adjusting the heating current and the variable leak *W* in the brake-field circuit. Practical tests of such an arrangement (Fig. 9) showed sharp resonance maxima and very high sensitivity: a wave-band of 40–80 cm could be covered without a change of sensitivity becoming apparent by comparison with other receivers, though for best results the dipole should no doubt be chosen to conform as closely as possible with the signal wavelength.

If the grid potential is varied over a wide range, a succession of resonance points appear, as in the simple brake-field audion. The resulting frequency spectrum (Fig. 10) does not exactly follow the n^2E_g = const. condition given by the writer's theory of "ultra-dynamic" excitation, owing to the field distortion between the segments. The special irregularity at 60–70 v must be due to slight constructional asymmetries or internal resonances.

The high sensitivity, combined with the aperiodic detection, renders the arrangement very open to all kinds of interference, particularly if the decimetre wave is transmitted by way of an intermediate wave (*e.g.* for duplex purposes—Carrara, 1933, p. 54). To cut out such interference the whole receiver, vertical dipole and all, may be statically screened by being enclosed in an earthed vertical spiral short-circuited by length-wise straps connected to each turn, allowing only the horizontally polarised waves to penetrate to the receiver.

Die Binode in der Rückkopplungsschaltung (The Binode [Combined Diode and Triode or Tetrode, with Common Cathode] in the Retroaction-Coupling Connection).—H. Pitsch. (*Funktech. Monatshefte*, December, 1933, No. 12, pp. 487–488.)

"It is generally considered that it is impossible to use retroaction with the binode . . . since the r.f. comes first only to the diode system, in which rectification but no amplification takes place. . . . The amplifying portion is generally employed for l.f. amplification, where again retroaction appears impossible. It is not hitherto fully realised that the l.f. system can well have r.f. applied to it in addition to the l.f., and that the r.f. amplified in the l.f. system can be used to provide retroaction." Figs. 1 and 3 give circuits by which this can be accomplished: in the well-known "series" circuit for the binode, shown in Fig. 2, the r.f. potentials arising in the resistance *W* are not in general sufficient to give retroaction.

The writer concludes: "With the introduction of retroaction the advantages of the binode (linear rectification and simple fading compensation) are no longer obtained at the price of low sensitivity," and with the extensive use of binodes there will no longer be any objection, from the receiving point of view, to stations increasing their modulation.

The Possibility of Improving the Quality of Short-Wave Radiotelephony by using Receiving Aerials which by Directional Discrimination reduce the Number of Components received.—Friis and others. (*See* abstract under "Propagation of Waves.")

On the Equivalent Entrance Resistance of a Triode giving Leaky-Grid Detection [Application to Receiver Design].—Severini. (*See* under "Properties of Circuits.")

The Reduction of Filament-Battery Coupling in Amplifiers.—W. L. Watton: Bainbridge-Bell. (*Wireless Engineer*, January, 1934, Vol. 11, No. 124, pp. 17–21.)

In the use of complicated wireless receiving sets, or when using amplifiers of very high gain, trouble has frequently been experienced due to this cause. Bainbridge-Bell's first method of elimination (1931 Abstracts, p. 151), by connecting a decoupling condenser to the positive end of the filament in addition to the usual condenser to the negative end, has proved most useful in practice. "It was implicitly assumed in that paper that these condensers should be equal in value; but experiments now to be described show that, in general, this is not so." In most cases the introduction of the second condenser C_2, of a value of about four-fifths that of the usual condenser C_1, will reduce the coupling to a negligible amount: if the valve is used with the grid so negative that the valve is working at the bottom bend of its anode-current/grid-volts curve, C_2 should be about one-fifth of C_1.

Prevention of Signal Loss in Visual Reception due to Lack of Frequency Constancy at Transmitter, by Indicator showing Difference between Signal and Receiver Frequencies.—W. Runge. (German Pat. 580 785, pub. 19.7.1933.)

What is Demodulation? [Removal or Suppression of Modulation, *not* (as in America) Detection or Rectification].—G. W. O. H.: Fisher. (*Wireless Engineer*, January, 1934, Vol. 11, No. 124, pp. 1–2.) Editorial prompted by Fisher's letter on pp. 24–25.

Reception of Sub-Harmonics of Commercial Short-Wave Stations?—(*World Radio*, 5th Jan., 1934, Vol. 18, No. 441, p. 28.) *See* also *ibid.*, 19th Jan., 1934, Vol. 18, No. 443, p. 97, and 2nd Feb., No. 445, p. 161.

Conditions necessary for an Increase in Usable Receiver Fidelity.—A. N. Goldsmith. (*Proc. Inst. Rad. Eng.*, January, 1934, Vol. 22, No. 1, pp. 9–15.) The full paper referred to in February Abstracts, p. 91, r-h column.

Eliminating Second Channel Interference [with Wave-Trap Details].—(*Wireless World*, 26th January, 1934, Vol. 34, pp. 52–53.)

Background Noise in Amplifiers: the Spontaneous Action due to Thermal Agitation and Schrot Effects [and the Relative Importance of the Two Causes: Improvement of Signal/Noise Ratio: etc.].—E. B. Moullin and H. W. M. Ellis. (*Wireless Engineer*, January, 1934, Vol. 11, No. 124, pp. 21–23: summary of I.E.E. paper, with Discussion.)

Rectification and Detection [Mathematical Treatment with Application to "Conversion Detectors"].—Strutt. (*See* under "Properties of Circuits.")

Power-Grid Detection for Battery Sets.—H. Jackson. (*Wireless World*, 5th January, 1934, Vol. 34, p. 15.)

Describing a method of avoiding saturation of an a.f. transformer core by the relatively high anode current of a power-grid detector. This method, which is alternative to the customary "parallel-feed" arrangement, is to pass direct current through the secondary which is in opposition to that through the primary.

Superheterodyne Receivers : the Advantages of a High Intermediate Frequency [*e.g.* 400 kc/s].—(*World-Radio*, 19th Jan., 1933, Vol. 18, No. 443, p. 87.)

Band-Pass Effect obtained in New I.F. Design [I.F. Coupling Units giving High I.F. Selectivity without Side-Band Cutting].—K. Clough. (*Radio News*, November, 1933, Vol. 15, pp. 285–286.)

Valves or Stages ? [in the Classification of Receivers : the Desirability of the Use of Scientifically Defined "Stages"].—W. F. Floyd. (*Wireless Engineer*, January, 1934, Vol. 11, No. 124, p. 25.)

The Universal A.C.–D.C. III.—W. T. Cocking. (*Wireless World*, 19th and 26th January, 1934, Vol. 34, pp. 36–38 and 54–56.)

Further Development of the Universal Mains-Driven Receiver.—E. Schwandt. (*Funktech. Monatshefte*, December, 1933, No. 12, pp. 489–491.)

The Siemens 47 Receiver [3-Circuit Four-Valve, for D.C. and A.C.].—Siemens Company. (*Funktech. Monatshefte*, December, 1933, No. 12, pp. 495–499.)

A Radio Market That Caught the Manufacturers Napping [Receivers for Taxicabs].—(*Rad. Engineering*, December, 1933, Vol. 13, No. 12, p. 11.)

The Use of a Detector with Approximately Logarithmic Characteristic over a 1 : 10 Amplitude Range, for Fading Elimination.—Roosenstein and Runge. (German Pat. 580 991, pub. 19.7.1933.)

Die Zeitkonstante automatischer Fadingregler (The Time Constants of Automatic Fading Compensators [and Their Measurement]).—K. Nentwig. (*Funktech. Monatshefte*, December, 1933, No. 12, pp. 481–482.)

Q.A.V.C. [Mechanical System of Quiet Automatic Volume Control using a Sensitive Relay].—F. L. Hossell. (*Wireless World*, 19th January, 1934, Vol. 34, pp. 43–44.)

Radio Broadcast Receivers [of the International System Group].—J. S. Jammer and L. M. Clement. (*Elec. Communication*, October, 1933, Vol. 12, No. 2, pp. 104–116.)

The "Rejectostat" ["Filtrostat"] System of Eliminating Man-Made Interference. (*See* preceding reference.)

Decree of 1st December, 1933, determining the Obligations binding on Constructors, Exploiters, Retailers and Holders of Electrical Installations or Apparatus, to Avoid Radioelectric Interference.—(*Rev. Gén. de l'Élec.*, 30th Dec., 1933, Vol. 34, No. 26, pp. 927–928.)

The Third National Congress for Defence against Industrial Interference with Radio Communications.—(*Ibid.*, pp. 201–202 B.)

Regulations for the Protection of Broadcasting Reception [against Man-Made Interference].—J. C. de Fabel. (*Génie Civil*, 30th Dec., 1933, Vol. 103, No. 27, pp. 644–645.)

"Hum" in Short-Wave Receivers [and the Efficacy of Some Kinds of Aluminium Paint for Screening Purposes].—(*World-Radio*, 29th Dec., 1933, Vol. 17, No. 440, p. 898.)

On the Electric Sparks in the Ignition of an Internal Combustion Engine.—T. Te-Lou. (*Comptes Rendus*, 26th Dec., 1933, Vol. 197, No. 26, pp. 1720–1723.)

AERIALS AND AERIAL SYSTEMS

Rectangular Short-Wave Frame Aerials for Reception and Transmission.—L. S. Palmer and D. Taylor. (*Proc. Inst. Rad. Eng.*, January, 1934, Vol. 22, No. 1, pp. 92–114.)

Further development of the work dealt with in Abstracts, 1931, pp. 268–269, and 1932, p. 640. A further "formatising" condition has been established, the fulfilment of which leads to a large frame current : this condition is that the frame perimeter must be an integral number of wavelengths. The investigation has also been extended to transmitting frames : here again the second formatising condition holds good, for maximum frame current, but the first formatising conditions are different. The critical dimensions for maximum radiation in a given direction are not necessarily the same as those for maximum frame current. It is concluded from the theory that for maximum radiation perpendicular to the sides and in the plane of the frame the height and width should be 0.40λ and 1.0λ respectively. There is another set of critical dimensions if the transmitting frame receives reflected waves from the ground, for maximum re-radiation. Experimental confirmation of the theoretical results, on ultra-short waves, is described. *See* also next two abstracts.

The Action of a Tuned Rectangular Frame Aerial when Transmitting Short Waves.—L. S. Palmer and D. Taylor. (*Proc. Phys. Soc.*, 1st January, 1934, Vol. 46, Pt. I, No. 252, pp. 62–75.)

This paper describes a continuation of work dealt with in 1932 Abstracts, p. 526. Theory and experiments give the necessary conditions and dimensions of frame for maximum frame current and maximum radiation. *See* also preceding and following abstracts.

The Current-Distribution round a Short-Wave Frame [Receiving] Aerial [with Demonstration and Discussion].—L. S. Palmer, D. Taylor and R. Witty. (*Proc. Phys. Soc.*, 1st January, 1934, Vol. 46, Pt. I, No. 252, pp. 76–90.)

The positions and magnitudes of the current antinodes in the frame are deduced theoretically ; they are found to be fixed in space and independent of the orientation of the frame to the wave front and "the current at any point of a frame consequently varies as the frame revolves in its own plane." The calculated positions of the antinodes have been verified experimentally. *See* also above.

REFLECTOR FOR ULTRA-SHORT WAVES [Dipole inside Reflector filled with Medium of Dielectric Constant greater than Air, decreasing Step by Step from Back to Front of Reflector].—W. Ilberg. (German Pat. 581 840, pub. 3.8.1933: *Hochf:tech. u. Elek:akus.*, December, 1933, Vol. 42, No. 6, p. 219.)

GRAPHICAL METHOD FOR DETERMINING THE FUNDAMENTAL WAVELENGTH OF A BROADCASTING AERIAL.—C. E. Rickard. (*Marconi Review*, Nov./Dec., 1933, No. 45, pp. 3–7.)

" In the following article the graphical methods adopted for practical filter and transmission-line calculation are brought to bear on the design of aerials, and an abac has been developed which gives the wavelength of a broadcasting aerial as a function of its dimensions."

KURZWELLENANTENNEN (Short-Wave Aerials [and Their Modes of Action: including the Lindenblad Long-Wire Aerials, the Carter " V," the Bruce " Rhombus," and the Beverage Aerial]).—M. Bäumler. (*Zeitschr. V.D.I.*, 30th Dec., 1933, Vol. 77, No. 52, pp. 1369–1374.)

ÜBER DIE ELEKTRISCHEN EIGENSCHWINGUNGEN STAB- KREISBOGEN- UND SPIRALFÖRMIGER LEITER (The Free Electrical Oscillations of Conductors in the Form of Rods, Circular Arcs, and Spirals).—K. F. Lindman. (*Ann. der Physik*, 1933, Series 5, Vol. 18, No. 7, pp. 805–815.)

Measurements of the natural wavelength of the fundamental oscillations of cylindrical conductors give values which are systematically smaller than those calculated from Hallén's theory. The value obtained for the wavelength of the fundamental oscillation of a thin metallic circular ring with a very small opening, surrounded by air, agreed with that deduced from Hallén's theory. It was also qualitatively demonstrated that when a straight metallic wire is gradually bent into an almost closed circle, the wavelength of its fundamental first gradually decreases, reaches a minimum and then increases to a value somewhat greater than the value for the original straight wire. Experiments with wires wound in spiral form also agreed with theory for a small number of turns. *See* also Abstracts, 1933, pp. 101, 270, 445–446; 1932, p. 640 (Hallén).

VALVES AND THERMIONICS

A METHOD FOR REALISING THE FULL AMPLIFICATION FACTOR OF HIGH-MU TUBES [Type " 57 " Valve used as Load Resistance in Plate Circuit of another " 57 " acting as Amplifier: Amplification of 1 500–2 500 per Stage with only 300–600 Volts Plate Supply].—O. H. A. Schmitt. (*Review Scient. Instr.*, December, 1933, Vol. 4, No. 12, pp. 661–664.) *Cf.* Abstracts, 1933, p. 636, Meissner: *also* January, p. 39, Sewig and Kleinschmidt. *See* also below.

THE USE OF A VACUUM TUBE AS A PLATE-FEED IMPEDANCE.—J. W. Horton. (*Journ. Franklin Inst.*, December, 1933, Vol. 216, No. 6, pp. 749–762.)

Performance characteristics of considerable practical value are obtained with a single stage of amplification, using one screen-grid tube as the amplifier and another as the plate-coupling impedance. The work of E. R. Meissner (Abstracts, 1933, p. 636, l-h col.) on these lines is referred to in a footnote. *See* also Schmitt, above.

VOLTAGE FACTOR OF TRIODES [Survey of Methods of Measurement, and a New Method based on Fact that Electron Emission in an Incandescent Filament *in Vacuo* is accompanied by a Variation in Intensity of Current feeding that Filament].—T. Tirunaranachar. (*Indian Journ. of Phys.*, Part I, Vol. 8, 1933, pp. 83–90.)

THE BINODE IN THE RETROACTION-COUPLING CONNECTION.—Pitsch. (*See* under " Reception.")

INDIRECTLY HEATED DOUBLE-TRIODE VALVE WITH ANODE OF AMPLIFYING SYSTEM IN SERIES WITH CATHODE OF SECOND SYSTEM WHICH ACTS AS ANODE RESISTANCE AND IS CONTROLLED IN OPPOSITE PHASE.—Te-Ka-De. (German Pat. 580 920, pub. 18th July, 1933: *Hochf:tech. u. Elek:akus.*, December, 1933, Vol. 42, No. 6, pp. 218–219.)

VALVES FOR AMPLIFYING VERY SMALL POTENTIALS: ELIMINATION OF SHOT EFFECT AND LIBERATION OF ELECTRONS ALL WITH SAME LOW VELOCITY, BY EXCITING CATHODE BY MONOCHROMATIC LIGHT OF WAVELENGTH EQUAL TO LIMITING WAVELENGTH OF CATHODE MATERIAL.—Fleischmann and Schloemilch. (German Pat. 581 525, pub. 28th July, 1933.)

ELECTRONICS AND ELECTRON TUBES. PART IX. SPECIAL TUBES [including the FP–126 for Micro-Wave Oscillations].—E. D. McArthur. (*Gen. Elec. Review*, December, 1933, Vol. 36, No. 12, pp. 556–557.)

The end of the series referred to in Abstracts, 1933, pp. 395 and 506, l-h cols. The valves now discussed and illustrated include the FP–54 (low-grid-current tetrode—1931, p. 322, Du Bridge), the PJ–11 (low-noise valve, 1932, p. 587, Metcalf and Dickinson), and the FP–126, for brake-field generation of frequencies between 600 and 1 700 Mc/s (1933, p. 99, Potapenko).

A SPECIAL MAGNETRON WITH INDUCTIVE COUPLING BETWEEN ELECTRONS AND EXTERNAL SYSTEM [Cylindrical Anode with Edges of Single Longitudinal Split connected to Lecher System].—Mulert. (*See* abstract under " Transmission.")

THE PUSH-PULL BRAKE-FIELD AUDION VALVE.—Hollmann. (*See* long abstract under " Reception.")

ELECTRON OSCILLATIONS [Ultra-Short Waves] WITH TRIPLE-GRID VALVE.—Hamburger. (*See* under " Transmission.")

A 100 Kilowatt Vacuum Tube [Water-Cooled Anode: a Satisfactory Copper/Glass Seal: 3 Filament V's in Parallel].—H. E. Mendenhall. (*Bell Lab. Record*, December, 1933, Vol. 12, No. 4, pp. 98–102.)

A New 120 kw Vacuum Tube [Sealed-Off Type].—W. T. Gibson and G. Rabuteau. (*Elec. Communication*, October, 1933, Vol. 12, No. 2, pp. 86–89.)

Improvements in Grid Electrodes [Use of Metallic Wire in Insulating (*e.g.*, Quartz) Tubes to form Frame of Grid: Utilisation of Connections as Electrode Supports].—Telefunken. (French Pat. 753 993, pub. 28th October, 1933: *Rev. Gén. de l'Élec.*, 30th Dec., 1933, Vol., 34, No. 26, pp. 207–208 D.)

Crystallographic Investigations [of Nickel Cathodes activated by Barium Azide] with the Electron Microscope.—E. Brüche and H. Johannson. (*Zeitschr. f. tech. Phys.*, No. 11, Vol. 14, 1933, pp. 487–488.)

Discrepancy between Theory and Experiment in Cold Emission [Electrons Striking Glass give Emission as from a Contaminated Surface].—W. H. Bennett. (*Phys. Review*, 15th Nov., 1933, Series 2, Vol. 44, No. 10, pp. 859–860.)

Elektronenmikroskopische Beobachtungen über die Wanderung der Emissionssubstanz auf Oxydkathoden (Observations, with the Electron Microscope, of the Wandering of the Emission Substance on Oxide Cathodes).—E. F. Richter. (*Zeitschr. f. Physik*, 1933, Vol. 86, No. 11/12, pp. 697–709.)

In oxide cathodes with a system of lines scratched in the coating, a change appears to take place in that first the oxide-coated surface and then the lines appear to emit the electrons. This is shown by both electric and magnetic electron microscopes and is caused by wandering of the emission upon the cathode itself. The emitting substance is found to vaporise and deposit itself upon the lines: this has been found in the case of barium for several cathodes. By suitable choice of experimental conditions the emission change can be controlled. The observations and their explanation agree with modern views on the subject of the importance of metallic barium for the emission from oxide cathodes (*cf.* Gehrts, 1933 Abstracts, p. 41).

DIRECTIONAL WIRELESS

A Radio Direction Finder for Use on Aircraft [Zero-Centre Course Indication by Reversing a Single Loop Aerial which is Dissymmetrical with respect to Ground].—W. S. Hinman, Jr. (*Bur. of Stds. Journ. of Res.*, December, 1933, Vol. 11, No. 6, pp. 733–741.)

The reversal produces two equal but opposite distorted field patterns, and is accomplished by alternately grounding the ends of the loop through rectifier valves and applying the voltage induced in the loop to a radio receiver: the output of the receiver is also applied to the rectifiers, and a zero-centre course indicator is so connected that when the loop is grounded at one end the indicator deflects to one side in proportion to the voltage induced. The characteristics of the incoming signals are not destroyed when "on-course" indications are received, but a loud audio noise is produced when the loop is turned either side of "course." A preliminary reference was given in February Abstracts, p. 96, l-h column.

The Radio Equipment of the Italian Aircraft in the Atlantic Cruise.—(*Alta Frequenza*, October, 1933, Vol. 2, No. 4, pp. 618–624.)

The Radioelectric Services of the Second Transatlantic Air Cruise [Italian Hydroplanes].—(*Journal télégraphique*, September, 1933, Vol. 57, pp. 245–248.)

Le Sondage acoustique et le Balisage des Aéroports (Acoustic Sounding and Landing Directions at Air Ports).—E. Weiss: Laboureur-Dubois. (Summary in *Rev. Gén. de l'Élec.*, 23rd Dec., 1933, Vol. 34, No. 25, p. 200 D.)

The Determination of the Direction of Arrival of Short Radio Waves [Results as applied to Direction Finding].—Friis and others. (*See* end of abstract under "Propagation of Waves.")

ACOUSTICS AND AUDIO-FREQUENCIES

Symposium on "Wire Transmission of Symphonic Music and Its Reproduction in Auditory Perspective" [Philadelphia-Washington Experiment].—(*Elec. Engineering*, January, 1934, Vol. 53, No. 1, pp. 9–32 and 214–219.)

Including papers on Basic Requirements (H. Fletcher), Physical Factors (Steinberg and Snow), Loudspeakers and Microphones (Wente and Thuras), Amplifiers (Scriven), Transmission Lines (Affel, Chesnut and Mills), and System Adaptation (Bedell and Kerney).

Die Entzerrung der Rundfunkfernleitungen (Distortion Correction of Long-Distance Lines for Broadcasting).—L. Fenyö. (*T.F.T.*, November, 1933, Vol. 22, No. 11, pp. 275–277.)

Economical Design of Long-Distance Communication Lines by Non-Loaded Cable Circuits.—S. Matsumae and N. Shinohara. (*Journ. I.E.E. Japan*, November, 1933, Vol. 53 [No. II], No. 544, pp. 978–986: English summary, pp. 91–93.) Further development of the work dealt with in 1933 Abstracts, pp. 162–163.

Stabilised Feed-Back Amplifiers [giving Stability of Amplification, Reduction of Modulation Products, Prevention of "Singing," etc.: Principle of providing Excess Amplification and throwing it away by feeding Output back to Input].—H. S. Black. (*Elec. Engineering*, January, 1934, Vol. 53, No. 1, pp. 114–120.)

This is the principle referred to in the paper by Clark and Kendall (1933 Abstracts, p. 628) on "Carrier in Cable" experiments. 70 of these amplifiers were operated in series. In this particular field, amplifiers normally possessing good characteristics with respect to stability and freedom from distortion are made to possess superlatively good characteristics by the application of the feedback principle: while amplifiers in which performance, particularly as regards distortion, has been sacrificed to economy can have their characteristics improved. The paper gives the theory and also some experimental results.

The Design of Low-Frequency, Transformer-Coupled Amplifiers [from Viewpoint of Wave Filter Theory, to give Linear Response over a Wide Band].—W. S. Mortley. (*Marconi Review*, Nov./Dec., 1933, No. 45, pp. 25–30.)

The writer concludes:—" It is believed that this method of treatment is original, and the results appear very satisfactory. They are, in fact, equally as good as resistance-capacity coupling, over the aural range, whilst having the advantages of greater gain and of being applicable to a push-pull circuit."

Eine neuartige Endstufe (A New Output Stage [American Circuit for Large Outputs: Push-Pull Connection of Two-Grid Valves with Grids joined to form Triodes: Mode of Action and Advantages]).—F. Berg. (*Funktech. Monatshefte*, December, 1933, No. 12, pp. 472–474.)

Sub-Harmonics in Forced Oscillations in Dissipative Systems [Book Review].—P. O. Pedersen. (*Wireless Engineer*, January, 1934, Vol. II, No. 124, p. 27.) *See* 1933 Abstracts, pp. 626–627. The book is in English.

Distortion in Public Address Loudspeakers [Examination of Assumption that the Air acts Linearly].—N. W. McLachlan. (*Wireless Engineer*, January, 1934, Vol. 11, No. 124, pp. 26–27.)

Distribution of Loudspeaker Output in Rooms with Strong Echo, by Sound Channel with Openings opposite Each Listener [*e.g.* in Church Pews].—Telefunken. (German Pat. 581 341, pub. 29.7.1933: *Hochf: tech u. Elek:akus.*, December, 1933, Vol. 42, No. 6, p. 219.)

Related Nodal Lines on Square Membranes: Parts I & II [Theoretical Investigation applicable to Loud-Speaker Vibrations].—R. C. Colwell and J. K. Stewart. (*Journ. Franklin Inst.*, December, 1933, Vol. 216, No. 6, pp. 763–768 and 769–773.)

The Piezoelectric [Bimorph Rochelle Salt] Loud Speaker.—Brush Development Company. (*Wireless World*, 5th January, 1934, Vol. 34, pp. 5–6.)

A New Cone Loud Speaker for High-Fidelity Sound Reproduction [Large Output and Uniform Response from 80 to 10 000 Cycles/Sec.].—H. F. Olson. (*Proc. Inst. Rad. Eng.*, January, 1934, Vol. 22, No. 1, pp. 33–46.) The full paper, a summary of which was referred to in 1933 Abstracts, p. 452, l-h column.

Magnetic Recording and Reproducing [Marconi-Stille System].—(*Wireless World*, 5th January, 1934, Vol. 34, pp. 8–10.)

Sound Film Printing [from Variable Density Negatives: Extent and Cause of Printing Loss, and the Possibility of Its Reduction].—J. Crabtree. (*Bell Tel. System*, Monograph B-750: 28 pp.)

Theoretisches über den Tonabnehmer (Theoretical Treatment of the [Electro-Magnetic] Pick-up).—F. W. Gundlach. (*Funktech. Monatshefte*, December, 1933, No. 12, pp. 468–471.)

Microfoni per Ultrasuoni (Microphones for Supersonic Waves [Small Condenser Microphones for the Detection of Frequencies up to 90 000 Cycles/Second]).—G. Sacerdote. (*Alta Frequenza*, October, 1933, Vol. 2, No. 4, pp. 516–536.)

Previous types: design and calibration of the writer's type: application to the investigation of a Galton whistle, particularly the plotting of its radiation polar diagrams at various frequencies: similar investigation of an electrostatic telephone: suggested applications to researches on pressure waves of very short duration (30–40 microseconds); in conjunction with the Grützmacher beat-frequency method, to the spectrum analysis of supersonic fields; to the investigation of musical instruments; etc., etc. The writer's design is carried out in two sizes, one " medium " and the other " small ": the very thin and tightly stretched diaphragm has a free surface of about 1 cm radius in the former and about one-third of this in the latter.

A Device for Measuring Sound Pressures in Free Air [Alternative to " Miniature " Condenser Microphone: Addition of Special " Mouthpiece " to Ordinary Condenser Microphone].—W. West. (*P.O. Elec. Eng. Journ.*, January, 1934, Vol. 26, Part 4, p. 260.) For the " miniature " microphone *see* Harrison and Flanders, 1932 Abstracts, p. 589.

Minimising Modulation in Transformers, *and* A Transmission Measuring Circuit for Transformers.—E. T. Hoch: J. S. Elliott, Jr. (*Bell Lab. Record*, December, 1933, Vol. 12, No. 4, pp. 117–119: 120–122.)

Beat Frequency Oscillator [and an Oscillogram of the Ripple in the H.T. Supply: " Valve Hiss "].—A. W. Stewart: Cooper and Page. (*Wireless Engineer*, December, 1933, Vol. 10, No. 123, p. 663.) Criticism of a statement in the paper dealt with in January Abstracts, p. 42, r-h column.

The Beat Frequency Oscillator [Practical Points for the Design of Satisfactory Constant Amplitude, Variable-Frequency Heterodyne Oscillators].—M. Slaffer: Cooper and Page. (*Wireless Engineer*, January, 1934, Vol. 11, No. 124, pp. 25–26.)

Arising from the Cooper-Page article referred to in Jan. Abstracts, p. 42, r-h column.

Noise Recorder [for Railway Noise Investigations].—W. Allen. (*E.T.Z.*, 4th Jan., 1934, Vol. 55, No. 1, pp. 15–16: short summary only.)

FREE ON NOISE [Note on Latest Form of Free's Noise Meter].—E. E. Free. (*Journ. Franklin Inst.*, December, 1933, Vol. 216, No. 6, pp. 815–817.)

ON MINIMUM AUDIBLE SOUND FIELDS [Data taken on 14 Ears over Frequency Range 100 to 15 000 Cycles/Second].—L. J. Sivian and S. D. White. (*Journ. Acous. Soc. Am.*, No. 4, Vol. 4, 1933, pp. 288–321.) For a formula correction see *ibid.*, No. 1, Vol. 5, 1933, p. 60.

THE ABSORPTION OF SOUND [in Gases: Short Survey of Recent Work and Its Implications].—V. O. Knudsen. (*Review Scient. Instr.*, December, 1933, Vol. 4, No. 12, pp. 637–639.)

ACOUSTIC ABSORPTION.—D. Faggiani. (*Nature*, 20th Jan., 1934, Vol. 133, p. 108: Note on recent Italian papers.)

A new theory of acoustic absorption by porous materials is advanced, " based on a consideration of the conditions of resonance of the very small channels into which the porous absorbing strata may be regarded as sub-divided." Theoretical conclusions agree well with experimental data.

FELT-COATED METAL SHEETS [for Studios, Receiver Cabinets, Baffles, etc.].—(*Electronics*, October, 1933, p. 288.)

THE MEANING OF DISTORTION [Series of Four Articles dealing particularly with the Subjective Aspect of Distortion: Part I].—F. M. Colebrook. (*World-Radio*, 26th January, 1934, Vol. 18, No. 444, pp. 127 and 128.)

DI UN EFFETTO STRANO NELLA LOCALIZZIONE DELLE IMMAGINI SONORE (On a Strange Effect in the Localisation of Sound Images [Image located close to Plane Reflecting Surface instead of at a Point symmetrical to Source and Surface]).—V. Ronchi. (*La Ricerca Scientifica*, October, 1933, 4th Year, Vol. 2, No. 7/8, pp. 241–243.)

THE PRODUCTION OF SOUNDS FROM HEATED METALS BY CONTACT WITH ICE AND OTHER SUBSTANCES, *and* NOTE ON THE VIBRATING PROPERTIES OF METALS AT DIFFERENT TEMPERATURES.—M. D. Waller. (*Proc. Phys. Soc.*, 1st January, 1934, Vol. 46, Pt. I, No. 252, pp. 116–123: 124–127.) For a previous paper *see* 1933 Abstracts, p. 167.

THE METHOD OF ZONE VARIATION [Gebietsvariation] APPLIED TO TWO ACOUSTICAL PROBLEMS [Natural Frequencies of Air-Filled Tubes of Deformed Cylindrical and Conical Shapes].—N. Artemieff. (*Physik. Zeitschr. der Sowjetunion*, No. 4, Vol. 4, 1933, pp. 628–636.)

ON THE INTENSE SUPERSONICS AND ITS APPLICATIONS [Quartz Oscillator of 2 × 250 Watts, 464 kc/s: Great Acceleration of Chemical Reactions: Emulsions of Mercury, Wood's Metal, etc.: Haemolysis of Blood].—H. Oyama. (*Journ. I.E.E. Japan*, December, 1933, Vol. 53 [No. 12], No. 545, pp. 1088–1094: English summary, p. 110.)

ECHO SOUNDING [Papers on].—Hayes: Tscherning: Marti. (*Hydrographic Review*, November, 1933, Vol. 10, No. 2, pp. 130–175.)

Report on sea trials of deep water echo sounding gear in H.M.S. *Challenger* and *Ormonde*: echo sounding in motor boats, a description of the British Admiralty supersonic shallow-water gear: the new ultrasonic sounders and their use in hydrography: determination of the slope of the sea bottom by a single acoustic sounding.

RADIO ACOUSTIC RANGING [by Hydrophones: Coast and Geodetic Survey Technique].—D. Belcher. (*Electronics*, November, 1933, pp. 308–309.)

RECENT PROGRESS IN THE DEVELOPMENT OF THE ECHOLOT [Echo Sounding Equipments].—W. Kunze. (*Zeitschr. V.D.I.*, 25th Nov., 1933, Vol. 77, No. 47, pp. 1265–1267.)

THE ACOUSTIC MEASUREMENT OF DEPTHS OF WATER [Sounding].—E. Lübcke. (*Zeitschr. f. Fernmeldetech.*, 15th Aug., 1933, Vol. 14, No. 8, pp. 119–126.)

LE SONDAGE ACOUSTIQUE ET LE BALISAGE DES AÉROPORTS (Acoustic Sounding and Landing Directions at Air Ports.).—E. Weiss: Laboureur-Dubois. (Summary in *Rev. Gén. de l'Élec.*, 23rd Dec., 1933, Vol. 34, No. 25, p. 200 D.)

PHOTOTELEGRAPHY AND TELEVISION

EIN VORSCHLAG ZUR DURCHFÜHRUNG VON FERNSEHPROGRAMMEN (A Suggestion for the Carrying Out of Television Programmes [Television Transmissions *as Illustrations to Ordinary Sound Programmes*, to Encourage Development without Waste of Money or Programme-Time]).—R. Thun. (*Funktech. Monatshefte*, December, 1933, No. 12, Supp. pp. 65–66.)

EIN VERFAHREN ZUR BILDZUSAMMENSETZUNG BEI BRAUNSCHEN RÖHREN (A Method of Image Synthesis with Cathode-Ray Tubes [Suggested Simplification and Popularisation of Television by the Transmission of Picture- and Line-Change Voltages over a Second (Sound) Channel, eliminating " Kipp "-Circuit Devices at the Receiver]).—F. von Okolicsanyi. (*Funktech. Monatshefte*, December, 1933, No. 12, Supp. pp. 71–73.)

PICTURE SHAPES AND SCANNING LINES [Considerations regarding Choice of Standard Picture Ratio].—R. Desmond. (*Television*, January, 1934, Vol. 7, No. 71, pp. 23–24.)

A STUDY OF TELEVISION IMAGE CHARACTERISTICS [particularly Image Detail for Different Numbers of Lines: Results given in Charts showing Relationships between Scanning Lines, Picture Size, Viewing Distance, and Desired Ratios of Picture Height to Viewing Distance].—E. W. Engstrom. (*Proc. Inst. Rad. Eng.*, December, 1933, Vol. 21, No. 12, pp. 1631–1651.)

An Experimental Television System [on 40–80 Mc/s Waves: Mechanical Scanning, 120 Lines: "Kinescope" Reception: Empire State Building Tests].—E. W. Engstrom: RCA Victor. (*Proc. Inst. Rad. Eng.*, December, 1933, Vol. 21, No. 12, pp. 1652–1654.)

Introducing the next three papers (*see* below). The frequency range "was found well suited for the transmission of television programmes. The greatest source of interference was from ignition systems of automobiles and airplanes, electrical commutators and contactors, etc. . . . To be satisfactory [except merely for carefully prepared and limited material] a television system should provide an image of more than 120 lines [*cf.* preceding abstract] . . . The fundamentals of the method of synchronising [one impulse for each line and one for each frame] were satisfactory. The superiority of the cathode-ray tube for image reproduction was definitely indicated. With the levels of useful illumination possible through the use of the cathode-ray tube, the image flicker was considered objectionable with a repetition frequency of 24 per second." For the propagation study connected with these tests *see* Jones, 1933 Abstracts, p. 334.

Description of an Experimental Television System and the Kinescope.—V. K. Zworykin. (*Ibid.*, pp. 1655–1673.)

See preceding abstract. The cathode-ray tube ("kinescope") used in receiving is discussed at some length, and its various characteristic curves are given; the mechanical scanning at the transmitter is then outlined, and the writer passes on to a discussion of the synchronisation method employed. Fig. 16 shows how the composite signal to the modulating grid is made up of picture modulation and horizontal and vertical synchronising signals. Both the latter are arranged to have their peaks on the negative side of the axis (whereas the picture modulations are usually more positive than negative) and differ in form owing to the shapes of the corresponding openings in the scanning disc [*see* next abstract]: this difference is utilised for filtering the two synchronising signals apart at the receiver ["wave-front selection"], while both of them are kept away from the picture signals by amplitude selection.

Description of Experimental Television Transmitting Apparatus.—R. D. Kell. (*Ibid.*, pp. 1674–1691.)

See also preceding abstract. It is pointed out that while it is practically true that the cathode-ray beam is inertialess, the inertia of the deflecting circuits is such that about one-tenth of the scanning time is required for the return of the scanning beam across the screen: this has to be allowed for in spacing the transmitting scanning disc apertures. The mechanical designs of the film and studio scanners are described; the writer then deals with the frequency-response characteristics of the photoelectric cells used, and briefly with the amplifiers and their special coupling circuits (to produce a rising characteristic so that their response at 200 kc/s is about twice that at 1 kc/s), with the mixing processes in the control room, and with the picture and sound radio transmitters.

Description of Experimental Television Receivers [Aerials, Tuned Circuits, and Superheterodyne Amplifiers for Ultra-Short-Wave Reception].—G. L. Beers. (*Ibid.*, pp. 1692–1706.)

Description of the receivers used in the tests dealt with above. The unexpectedly small psychological effect of interference on the picture programmes is discussed at the end.

Système de Télévision par Tubes à Rayons cathodiques (A Television System using Cathode-Ray Tubes [Iconoscope and Kinescope]).—V. K. Zworykin. (*L'Onde Élec.*, November, 1933, Vol. 12, No. 143, pp. 501–539.) *See* February Abstracts, p. 101, l-h column.

The Iconoscope—a Modern Version of the Electric Eye.—V. K. Zworykin. (*Proc. Inst. Rad. Eng.*, January, 1934, Vol. 22, No. 1, pp. 16–32.) *See* also February Abstracts, p. 101, l-h column: also above.

Über die Frequenzabhängigkeit der Braunschen Röhre mit Gaskonzentration (The Frequency Dependence [between 10^4 and 10^6 c/s] of the Cathode-Ray Tube with Gas Concentration).—W. Heimann. (*E.N.T.*, December, 1933, Vol. 10, No. 12, pp. 476–485.)

In a preliminary communication (Abstracts, 1933, p. 51) the writer called attention to the change of sensitivity at frequencies above 10^4 c/s. The present paper concentrates particularly on the frequency band 10^4–10^6 c/s, which the writer considers has hitherto been inadequately dealt with. "We shall see that in this range we have to deal with phenomena arising from the effect of the ions in the *ray space* [between deflecting system and screen], in contrast to the sensitivity changes dealt with by McGregor-Morris (*Journ. I.E.E.*, 1925) and Hollmann (Abstracts, 1933, p. 634) which do not set in till about 10^8 c/s and are due to effects in the *deflecting condenser space*."

The tests were made over a range from 50 to 10^7 c/s. Two effects were found to superpose themselves on the usual behaviour of the tubes: these are named "first and second high-frequency anomalies." The first anomaly is a sharp maximum in the sensitivity curve at about 5×10^4 c/s; it is due to the superposition of natural oscillations of the electron ray. These ray vibrations occur even when there are no deflecting potentials, and can be made evident by stroboscopic disc or rotating mirror as well as by a resonance circuit connected to anode and deflecting plates. Their frequency depends on the space-charge density and especially on the nature of the gas: for xenon, krypton and argon the frequencies found were inversely proportional to the square root of the mass. Von Ardenne's explanation of the wavy lines on the television screen, in place of the normal straight lines, as a result of ion oscillations of frequency calculable from the temperature velocity of the ions and from the tube dimensions, is disputed; but the writer agrees that even his own results do not yet completely elucidate the phenomenon.

The "second high-frequency anomaly" shows itself as a decreased sensitivity (and a loss of spot sharpness) setting in at about 10^5 c/s. This is shown to be caused by a collecting of ions in the fan-shaped space passed over by the ray in its movements. A calculation given on p. 484 for the onset of the second anomaly in an argon-filled tube agrees with the observed effect. The decrease in sensitivity continues as the frequency is raised, until the whole fan-shaped space is filled with ions; after that the sensitivity remains constant.

The sensitivity maximum of the first anomaly (Fig. 6), being a result to the negative space charge, is entirely absent in the curves of Fig. 10, where the usual form of tube was replaced by a spherical container. Such a form is inconvenient in practice, but a similar result can be obtained (Fig. 11) by metallising the inside of the ordinary tube and bringing the metallic layer to the anode potential. The resulting removal of the negative space charge in the space between plates and screen is also advantageous as regards the second anomaly and the behaviour to frequencies above 10^5 c/s, since it allows a lower gas pressure to be employed.

Untersuchungen über achromatische Elektronenlinsen (Investigations on Achromatic Electron Lenses).—M. von Ardenne. (*Zeitschr. f. Physik*, 1933, Vol. 86, No. 11/12, pp. 802–809.)

This theoretical paper discusses the chromatic errors of a lens, which are defined in optics and electron optics by the fluctuation of the focal length. In electron optics this is fixed by the dependence of focal length on electron velocity, of which it is a steadily increasing function. Two conditions are deduced for achromatic focusing lenses, which show that a magnetic defocusing lens and an electric focusing lens suffice to construct an achromatic focusing lens, whereas the construction of an achromatic defocusing lens requires a magnetic focusing lens and an electric defocusing lens. The equations necessary for calculating the details of the system are given and it is shown that the magnetic defocusing lens is physically and technically possible.

Über eine indirekt geheizte Kathode für Braunsche Röhren (An Indirectly Heated Cathode for [Gas-Filled] Cathode-Ray Tubes [Advantages of Indirect Heating, including Large Oxide Reserve, Choice of Size and Shape of Emitting Surface, Constancy of Centre of Emission: Description of the Writer's New Standard Cathode]).—M. von Ardenne. (*Funktech. Monatshefte*, December, 1933, No. 12, Supp. pp. 67–69: *Hochf:tech. u. Elek:akus.*, December, 1933, Vol. 42, No. 6, pp. 216–218.)

Television in 1934 [Plea for Continuation of 30-Line in addition to High-Definition Transmissions: Photographs of "Scophony" Rotating-Echelon Equipment].—S. Sagall: Walton. (*Television*, January, 1934, Vol. 7, No. 71, pp. 4–6.)

The Scophony system is based on the inventions of G. W. Walton. In the course of his article Sagall remarks that "a 30-line B.B.C. picture on the Scophony receiver is nearly as good as a 90-line cathode-ray picture." The Scophony type of film, based on Walton's "stixograph" invention, is also of value for animated pictures, "as it is a true continuous record. Intermittency of exposure and [of] movement of film is eliminated, and the rate of movement of film is 1–5 mm per sec. compared with the 450 mm per sec. of ordinary film." For Walton's photocell *see* 1933 Abstracts, pp. 107–108.

The Design of Television Transmission Equipment [Fundamental Principles of Design of Optical Systems for Exploration by Baird Spotlight Method: Comparison of Nipkow Disc, Mirror Drum and Lensed Disc as regards Optical Efficiencies: etc.].—J. C. Wilson. (*Journ. Television Soc.*, September, 1933, Series II, Vol. 1, Part 8, pp. 237–271).

Suggested Terms and Symbols to be used in Television.—(*Journ. Television Soc.*, September, 1933, Series II, Vol. 1, Part 8, p. 272.)

A Novel Receiving System [Nipkow Disc with Electrodeless Neon Lamps cemented in Holes and excited by Fixed High-Frequency Field].—E. L. Gardiner. (*Television*, January, 1934, Vol. 7, No. 71, pp. 19–20.)

Prevention of the Obscuring of Luminous-Cathode Light Sources due to Cathode Sputtering of Bulb, by use of Inclined Mirror and White-Metal Cathode giving Bright Deposited Surface.—Fotos Lamps Company: Pelletier and others. (French Pat. 753 774, pub. 24.10.33; *Rev. Gén. de l'Élec.*, 30th Dec., 1933, Vol. 34, No. 26, pp. 205–206 d.)

On the History of the Development of the Glow-Discharge Cell.—P. Hatschek. (*Funktech. Monatshefte*, December, 1933, No. 12, Supp. pp. 69–70.)

Selectivity or Frequency Response? [Discussion of Methods of Retaining Higher Television Frequencies without Excessive Interference from Other Stations].—S. R. Wilkins. (*Television*, January, 1934, Vol. 7, No. 71, pp. 27–28.)

Transients in Transformer-Coupled Amplifiers.—Nowotny. (*See* under "Properties of Circuits.")

High-Frequency [Carrier-Current] Telephony on Lines, with Short Carrier Waves [5 000 m to 40 m: Increased Damping compensated by Low Noise Level: Application to Television Transmission].—F. Kirschstein and J. Laub. (*E.N.T.*, December, 1933, Vol. 10, No. 12, pp. 457–466.)

Hitherto the custom has been to use carrier frequencies of 5 000–40 000 c/s, on the supposition that the damping of higher-frequency carriers would be excessive. The writers' tests, for the German Post Office, on carriers of much shorter wavelength (between 5 000 and 40 metres) along overhead lines of 4-mm copper, showed that the damping values over the whole wave-range corresponded to those calculated on the basis of skin effect: no additional damping due to radiation could be found. Moreover, the noise level, particularly at the shorter wavelengths, was so low that the permissible total transmission loss could well be as much as 10–12 Nepers instead of the usual limit of 4–5. With a few watts of transmitting power, therefore, carriers in the broadcast range gave ranges up to 500 km; over cables, carriers above 1 000 m gave ranges of 50 to 100 km. Carriers under 100 m, on overhead lines, gave as a rule ranges below 100 km, and would therefore be of little use for telephone services.

The writers point out the advantages of the broadcast-frequency carriers over the previous long-wave carriers, in providing many more channels, in requiring far simpler filtering arrangements, and in using apparatus which can be manufactured cheaply side by side with ordinary broadcasting apparatus. Further investigation will be needed before the possible difficulties involved can be properly gauged. The present tests (which also include some on iron-wire lines) were primarily in connection with the transmission of television programmes over overhead lines.

Das Verhalten des Widerstands-Kapazitäts-gekoppelten Verstärkers bei Schaltvorgängen (The Behaviour of the Resistance-Capacity-Coupled Amplifier to Switching [Transient] Processes [with Particular Reference to Television Transmission]).—G. Kroker and S. Felgentreu. (*T.F.T.*, November, 1933, Vol. 22, No. 11, pp. 277–287.)

From the authors' summary:—The paper deals with mathematical and experimental investigations of resistance-capacity-coupled amplifiers of any number of stages. . . . With the help of simple differential calculus the time-course of the amplifier output voltage is determined for sudden illumination changes at the photocell (switching processes). The result of the theoretical treatment is confirmed by oscillograms of the television amplifier of the Witzleben (*FVW*) ultra-short-wave transmitter. The result affords an explanation of a number of distortions in the televised image [contrast distortion, fogging of the image for sudden changes in the average brightness, greyness of large combinations of black or white surfaces, "plastic" (pseudo-solidity) and multiple outline effects]. . . . One fact is fundamentally responsible for all these phenomena: that for sudden changes of the input voltages to the amplifier the coupling condensers of every stage first of all take up energy as a result of the voltage impulse and then give it up again as the opposed voltage of the impulse gradually decays. Since the instants of reversal of flow in the various stages are generally different, the superposition of these differently amplified components in a series of stages causes the disturbance oscillations, decaying non-harmonically, shown in Fig. 3. By a suitable choice of the time constants of the various stages the disturbing effect of these oscillations can be diminished and the image quality improved.

Photokathode und Sperrschichteffekt (Photocathode and Barrier-Layer Effect).—P. Görlich. (*Naturwiss.*, 5th Jan., 1934, Vol. 22, No. 1, pp. 11–12.)

A preliminary letter on experiments with composite photocathodes (Cs_2O films with embedded Cs and Ag atoms) was dealt with in January Abstracts, p. 41. These show a good rectifying action and a photocurrent (of magnitude 10^{-7} to 10^{-8} amp./lumen) in the sense of a "front wall" effect at cathodes with a high external photoelectric emission. After the film has been sensitised, it is necessary to attach a counter-electrode (in the form, say, of a ring) to the film by means of a magnet. Temperature effects were completely excluded in the experiments. When the external photoelectric effect (using an auxiliary voltage) and the barrier-layer effect (without bias) are measured at the same cathode, superposition of the two currents may be obtained by suitable choice of the external circuit elements. Experiments on various films and the spectral distribution of the barrier-layer effect are in progress.

Die Elektronenleitung des Kupferoxyduls (The Electron Conduction of Cuprous Oxide).—W. Schottky and F. Waibel. (*Physik. Zeitschr.*, 1st Dec., 1933, Vol. 34, No. 23, pp. 858–864.)

This paper contains an experimental investigation of the Hall effect in cuprous oxide at temperatures between −180°C and 850°C; the effect is found to change sign in the temperature range 400–500°C. The results are discussed theoretically on the basis of wave-mechanical arguments. The investigation was undertaken originally for the purpose of attempting to explain the effect of the barrier layer, and the results seem to favour the theory of the imperfect conductivity of the layer.

Zur Theorie des Kristallphotoeffektes (Theory of the Crystal Photoelectric Effect [Refutal of Criticism]).—H. Teichmann. (*Physik. Zeitschr.*, 15th December, 1933, Vol. 34, No. 24, p. 897.)

The writer's theory of the crystal photoelectric effect, referred to in Abstracts, 1933, p. 170, has been criticised by Deaglio (1933, p. 573); the present short preliminary note gives reasons for regarding the criticisms as invalid. *See* also next abstract.

Bemerkungen zu Einwänden gegen meine Theorie des Kristallphotoeffektes (Remarks in Answer to Objections to My Theory of the Crystal Photoelectric Effect).—H. Teichmann. (*Zeitschr. f. Physik*, 1933, Vol. 87, No. 3/4, pp. 264–272.)

Author's summary:—"Various objections to the pure electron theory of the crystal photoelectric effect are discussed and experiments are described which show that the observations, brought forward by R. Deaglio [Abstracts, 1933, p. 573] in support of his hypothesis of the electrolytic conductivity of cuprite under illumination, can be explained by the temperature variation of the crystal photoelectric effect." *See* also preceding abstract.

Action of Light on Thin Metallic Films [Increased Resistance not attributable only to Thermal Effect].—Q. Majorana. (*Nuovo Cimento*, July, 1933, Vol. 10, No. 7, pp. 261–285.). *See* 1933 Abstracts, p. 278.

Photoelectric Yields in the Extreme Ultra-Violet.—C. Kenty. (*Phys. Review*, 1st Dec., 1933, Series 2, Vol. 44, No. 11, pp. 891–897.)

The surfaces examined were Ni, W, Mg, W–O and

Constantan, and the illumination used was the extremely short wavelength radiation given out by the positive columns in He, Ne and A. The maximum of the yield for most ordinary metal surfaces was found to lie probably on the short wavelength side of 584 A. In general, un-degassed metals gave yields several times greater than well-degassed ones. " The photoelectric emission from probe and cathode surfaces in the rare gases may be of considerable importance."

The Effect of Temperature on the Energy Distribution of Photoelectrons : I. Normal Energies : II. Total Energies.—L. A. Du Bridge and R. C. Hergenrother : W. W. Roehr. (*Phys. Review*, 1st Dec., 1933, Series 2, Vol. 44, No. 11, pp. 861–865 : 866–871.)

Zur Bestimmung der Planckschen Konstante aus .Geschwindigkeitsmessungen an Photoelektronen (The Determination of Planck's Constant from Measurements of the Velocity of Photoelectrons).—S. Prilɛžaev : Du Bridge. (*Zeitschr. f. Physik*, 1933, Vol. 87, No. 1/2, pp. 28–31.)

The Influence of the Layer of Adsorbed Gas on the Photoelectric Sensitivity.—B. Abendroth. (*Zeitschr. f. Physik*, 1933, Vol. 85, No. 7/8, pp. 530–544.)

Platinum, which has become photoelectrically insensitive by long, intensive heating, becomes effective again when covered with thin films of various vapours ; thicker films decrease the sensitivity again. The reverse process occurs if the platinum is now heated. Cadmium iodide behaves like platinum.

The Absorption of Thin Layers of Cu, Ag and Au in the Visible and Ultraviolet Region [from 700 to 186 mμ].—A. Smakula. (*Zeitschr. f. Physik*, 1933, Vol. 86, No. 3/4, pp. 185–194.)

The Absorption of Light by Metals.—A. Smakula. (*Physik. Zeitschr.*, 1st Nov., 1933, Vol. 34, No. 21, pp. 788–790.)

A short account of an experimental determination of the regions of transparency of Cu, Ag and Au and other metals in the short wave region (700 to 186 mμ.).

Theories of the Photoelectric Effect [Survey]. —K. K. Darrow. (*Review Scient. Instr.*, September, 1933, Vol. 4, No. 9, pp. 467–472).

MEASUREMENTS AND STANDARDS

Eine neue Methode zur Bestimmung elektrischer Wellenlängen (A New Method of Measuring Electric Wavelengths [Adjustment and Identification of Harmonics of Oscillator coupled to Quartz Circuit, by use of Supersonic Waves in Trough of Liquid as an Optical Diffraction Grating]).—L. Bergmann : Debye and Sears. (*Funktech. Monatshefte*, December, 1933, No. 12, pp. 474–477.)

Making use of Debye and Sears' optical method of demonstrating the oscillations of a quartz crystal (1932 Abstracts, p. 576, r-h col.) the writer adjusts his signal-generator wavelength downwards until the loosely coupled quartz circuit starts oscillating at the fundamental frequency of the quartz, producing side-images on either side of the slit image projected on the screen : *the adjustment is extraordinarily sharp*. On decreasing the generator wavelength further, the side-images again appear, but at a greater distance from the central image. By measuring these spacings of the side-images on either side of the central image, the order of the quartz harmonics can be identified. Fig. 4 shows a photographic record going up to the 55th harmonic.

Radiometric Condensers and Inductances (including the Application of the Zero-Shunt Principle to Ultra-Short-Wave Oscillators, and New Methods for Wavelength Measurement).—G. G. Blake. (*Journ. Roy. Soc. Arts*, 22nd December, 1933, Vol. 82, No. 4231, pp. 154–180.)

Part of the ground explored by this paper has already been covered in the article dealt with in Abstracts, January, p. 48. The writer's " type A molecular radiometric condenser " (with hanging leaf), and a number of circuits in which it has been used, are discussed and illustrated. Even when the vacuum was increased to 10^{-7} mm Hg (with the idea of eliminating gas effects and obtaining a condenser whose capacity would *increase* under the pressure of light) it was found that comparatively strong gas action still remained and that heat radiations moved the foil *towards* the incident radiation and away from the back electrode. In one circuit tested, where a circuit consisting of the radiometric condenser and an inductance was suitably coupled to an oscillator tunable around 1 Mc/s, as resonance was approached the electrostatic field within the radiometric condenser became sufficiently strong to move the foil and thus to bring the radiometric condenser automatically into tune (*cf.* Benndorf's condenser with negative capacity, 1933, p. 460, l-h col.). Still closer coupling brought a point at which the leaf oscillated continuously.

With a 5-metre wavelength the condenser was extremely sensitive, the zero-shunt-circuit galvanometer giving a large deflection for an illumination by an incandescent lamp several yards distant. It was incomparably more sensitive than a 36-couple thermopile. The type B condenser (leaf blackened on front side) gave a momentary Crookes' radiometer action (pressure of light forcing leaf towards back-plate) followed immediately by the gas-action motion towards the incident radiation, the leaf coming to rest in equilibrium between the two forces: on removing the radiation the pressure behind the leaf forced it forward. Bimetallic condensers are described, and Dingee's work is mentioned (1932, p. 297, r-h col.).

In the subsequent discussion Coursey suggests that for practical applications troubles due to vibration could be lessened by using an element tuned to a definite frequency, and that perhaps the thermometer device might be useful as a very delicate thermostat for certain purposes. Megaw refers to the converse use of radiometric measurements for the detection of micro-waves. Child suggests that the behaviour of the type B condenser makes it specially suitable for guard-ray working, *e.g.*, for warning vehicles as they pass a particular spot and interrupt the heat beam.

Eine stationäre Einrichtung zur Präzisionsmessung hoher Frequenzen (A Stationary Equipment for the Exact Measurement of High Frequencies [at the U.S.S.R. State Laboratories]).—A. Wainberg and L. Segebart. (*E.N.T.*, December, 1933, Vol. 10, No. 12, pp. 472–476.)

For an accuracy of the frequency standard within $\pm 10^{-6}$ the total error of the equipment is about ±0.005 % at 100 kc/s and from ±0.00015 to ±0.00005% at 10 Mc/s. The frequency standard is of 200 kc/s and works in conjunction with four Abraham-Bloch multivibrators of fundamentals 1, 10, 100 and 1 000 kc/s. The total range of the equipment, in three bands, reaches to 30 Mc/s. The procedure is that of zero beat, a special note generator with constant calibration (Fig. 7) being employed.

Confronto di Frequenze mediante l'Oscillografo a Raggi catodici (The Comparison of Frequencies with the Cathode-Ray Oscillograph [Theoretical and Experimental Treatment—Frequencies 15–500 Cycles/Second]). —S. Centineo. (*L'Elettrotec.*, 25th Dec., 1933, Vol. 20, No. 36, pp. 854–858.)

The M.G.8A Frequency Meter [100 to 3 000 Metres, Discrimination not less than 1 part in 10 000 at any Part of Band: Transportable: Visual Indication: Automatic Selection of Capacity by the Interchangeable Inductances].—(*Marconi Review*, Nov./Dec., 1933, No. 45, pp. 8–11: to be continued.)

The Precision of the Double-Circuit Radio and Audio-Oscillator.—N. W. McLachlan. (*Wireless Engineer*, December, 1933, Vol. 10, No. 123, p. 664.)

1934 Station Finder.—H. F. Smith. (*Wireless World*, 12th January, 1934, Vol. 34, pp. 20–21.)

Oscillation Forms of Piezoelectric Crystals [Photographs using Optical Interference Method].—H. Straubel. (*Physik. Zeitschr.*, 15th December, 1933, Vol. 34, No. 24, pp. 894–896.)

Constant Frequency Oscillator Circuit with Two Crystals with Temperature Coefficients of Opposite Sign.—F. R. Lack. (U.S.A. Pat. 1 915 368, pub. 27.6.1933: *Hochf:tech. u. Elek:akus.*, December, 1933, Vol. 42, No. 6, p. 218.)

Constant Frequency Oscillator [Temperature of Tuning Elements regulated by Heater Winding fed from Source whose Fluctuations would tend to affect the Frequency].—M. Osnos. (German Pat. 581 837, pub. 3.8.1933: *ibid.*, p. 218.)

Theories on Frequency Stabilisations and Amplitude Variation of Dynatron-Type Oscillators [and the Erroneous Ideas as to the Chief Cause of Frequency Variations].—Usui. (*See* under "Transmission.")

Broadcast Measuring Technique from Microphone, by way of Transmitting and Receiving Aerials and Broadcast Receiver, to Loudspeaker.—A. Clausing. (*Veröffentlichungen aus dem Gebiete der Nachrichtentechnik*, No. 2, 3rd Year, 1933, pp. 155–164.)

Radio Testing Instruments from the Engineering Viewpoint.—J. H. Miller. (*Rad. Engineering*, December, 1933, Vol. 13, No. 12, pp. 19–22 and 23.)

Visual Test Device [for Frequency-Response Curves: using Cathode-Ray Tube with Sine-Voltage Deflection and Sinusoidally Varying Rotating Condenser].—G. Ulbricht. (*Proc. Inst. Rad. Eng.*, January, 1934, Vol. 22, No. 1, pp. 89–92.) *See* January Abstracts, pp. 46–47.

An A.C. Potentiometer [Rectangular Coordinate Type: Elimination of Phase-Shifting Transformer and of Slide-Wire Contact (by use of Variometers)].—S. L. Burgwin. (*Elec. Engineering*, January, 1934, Vol. 53, No. 1, pp. 108–113.)

Neue Schleifdraht-Messeinrichtungen (New Slide-Wire Measuring Apparatus [A. C. Bridges using "Caterpillar"-Type Resistances with Rotating Contact sliding on Spiral bent into Circular Form]).—Th. Walcher. (*Zeitschr. f. Fernmeldetech.*, 22nd Dec., 1933, Vol. 14, No. 12, pp. 177–180.)

On Symmetry in Electrical Systems, particularly in Measuring Apparatus.—A. Wirk. (*Veröffentlichungen aus dem Gebiete der Nachrichtentechnik*, No. 2, 3rd Year, 1933, pp. 127–131.)

The Rectifying Peak Voltmeter as a Standard Instrument [using Overbiased Rectifying Valves: Calculation of Errors].—A. T. Starr. (*Proc. Phys. Soc.*, 1st Jan., 1934, Vol. 46, Pt. 1, No. 252, pp. 35–46.)

A Vacuum-Tube Voltmeter with Logarithmic Response [using Variable-Mu Valve, with Diode Rectifier to select Portion of Wave "compressed" by Characteristic Curvature]. —F. V. Hunt. (*Review Scient. Instr.*, December, 1933, Vol. 4, No. 12, pp. 672–675.)

The Attraction between Coils in the Rayleigh Current Balance.—C. Snow. (*Bur. of Stds. Journ. of Res.*, November, 1933, Vol. 11, No. 5, pp. 681–689.)

On a Method of Comparison of the Mutual Inductance between Two Coils with the Self Inductance of One of Them.—H. Mukherjee. (*Indian Journ. of Phys.*, Part I, Vol. 8, 1933, pp. 1–7.)

Characteristics of Resistance and Reactance of a Variometer consisting of Two Circuits in Parallel.—C. Chiodi. (*L'Elettrotec.*, 25th Dec., 1933, Vol. 20, No. 36, pp. 859–861.)

Modulation Meter [Differential Instrument fed by Two Rectifier Circuits with Different Time Constants].—F. E. Terman. (U.S.A. Pat. 1 915 558, pub. 27.6.1933: *Hochf:tech. u. Elek:akus.*, December, 1933, Vol. 42, No. 6, p. 218.)

The time constant of one circuit is large compared with the lowest frequency involved, that of the other small compared with the highest frequency.

The rectified current of the first circuit is thus proportional to the peak voltage, that of the second circuit to the average value. A ratio of 2 : 1 corresponds to 100% modulation.

MEASUREMENT OF THE HEATING OF LIQUIDS IN THE [Ultra-] HIGH-FREQUENCY CONDENSER FIELD —Malov. (*See* under " Miscellaneous.")

SUBSIDIARY APPARATUS AND MATERIALS

RAY-CONTACT DEVICES IN GAS-FILLED CATHODE-RAY TUBES FOR THE RECORDING OF SINGLE UNCONTROLLED PROCESSES.—M. von Ardenne. (*E.N.T.*, December, 1933, Vol. 10, No. 12, pp. 485–488.)

Investigation of the applicability to gas-filled tubes of the convenient device, already used in high-vacuum tubes, by which the arrival of the process sets the time-base in action by deflecting the ray away from a collector electrode, on which it falls when in its position of rest. For the small-current tubes under consideration the process times are rarely less than 10^{-3} or 10^{-4} sec., consequently a time-base release would be satisfactory if its delay time did not much exceed 10^{-5} sec. The delay time of such an arrangement depends on two factors: the distance the ray has to move from its repose position in order to set off the " kipp " circuit of the time base, and the electrical inertia of that circuit with its control elements (collector electrode, leak resistance, and leads).

Experiments with tubes whose screens are not provided with a leakage path show that if the collector cup is fixed near the screen the full ray current nearly always flows to the cup, no matter whereabouts on the screen the ray may terminate. " The explanation of this, at first sight surprising, phenomenon is that the 'durchgriff' of the collector cup on the secondary electrons emitted from the screen is large compared with the 'durchgriff' of the anode, at its long distance from the screen. The first thing to do, therefore, is to make the cup/screen-surface 'durchgriff' very small." Partly screening the cup with glass is one way of doing this: curve a of Fig. 2 shows the rather flat curve given by an unsatisfactory screening: the improved curve b is the result of the use of a glass tubular screen projecting 2 cm beyond the cup in the direction of the anode. With this arrangement a deflection of hardly more than a ray-diameter reduces the effective ray current to about one-fifth.

Fig. 3 shows the bad effect on the curve of too high a gas pressure. Since the primary object of the tube is to give a sharp record, the nature of the gas and its pressure are governed by this requirement. For the optimum conditions as regards gas-concentration of the ray the curve a of Fig. 4 is obtained. Curve b shows the result of connecting a 5×10^6 ohms resistance: the decrease of the maximum collector-cup current, and the accompanying increase of voltage drop, resulting from increased external resistance give valuable information for the design of the control circuit. The " kipp " circuit can easily be arranged to be set off by a voltage drop of 15 v: an external resistance of 6×10^5 ohms is more than enough to provide this, and if the capacities of the cup electrode, the control grid of the " kipp " circuit and the connecting leads are kept low by careful design, this resistance will give a control-circuit delay time of 10^{-5} sec. The " kipp " relay itself can have an even smaller delay, so that the whole combination is quite practicable for the type of recording under consideration.

INVESTIGATIONS ON ACHROMATIC ELECTRON LENSES.—von Ardenne. (*See* under " Phototelegraphy and Television," p. 159.)

AN INDIRECTLY HEATED CATHODE FOR CATHODE-RAY TUBES.—von Ardenne. (*See* under " Phototelegraphy and Television," p. 159.)

THE FREQUENCY DEPENDENCE [between 10^4 and 10^6 c/s] OF THE CATHODE-RAY TUBE WITH GAS CONCENTRATION.—Heimann. (*See* under " Phototelegraphy and Television.")

ELECTRICAL " KIPP " PROCESSES [with Description of a Number of Circuits for Glow-Discharge Tubes and Radio Valves (in the latter case for Frequencies from 10^{-1} to 10^7 Cycles/Second)].—W. Fucks. (*Physik. Ber.*, 15th Dec., 1933, Vol. 14, No. 24, p. 1993.)

THE USE OF A CONTROL ELECTRODE IN A GLOW-DISCHARGE TUBE FOR SYNCHRONISING A " KIPP " CIRCUIT.—E. Hudec. (German Pat. 581 157, pub. 22nd July, 1933: *Hochf: tech. u. Elek:akus.*, December, 1933, Vol. 42, No. 6, p. 218.)

RECORDING OF PATTERNS AND WAVES APPLIED TO CATHODE-RAY TUBE BY [Home Motion-Picture] CAMERA.—A. B. Du Mont. (*Rad. Engineering*, December, 1933, Vol. 13, No. 12, pp. 15 and 18.)

BRAUN CATHODE-RAY TUBES AND THEIR APPLICATION.—E. Alberti. (Book Review in *Hochf:tech. u. Elek:akus.*, December, 1933, Vol. 42, No. 6, pp. 219–220.)

DOUBLE-MIRROR GALVANOMETER AS CONSTRUCTED BY M. REICH [for Demonstration of Curves and many Other Purposes].—H. Hecke: Reich. (*Physik. Ber.*, 15th Dec., 1933, Vol. 14, No. 24, p. 1993.)

EFFECTS OF RECTIFIERS ON SYSTEM WAVE SHAPE [Computation of Harmonic Voltages and Currents (liable to cause Interference with Communication Circuits) and Discussion of Methods of Co-ordination].—P. W. Blye and H. E. Kent. (*Elec. Engineering*, January, 1934, Vol. 53, No. 1, pp. 54–63.)

ELECTRICAL DISCHARGES IN GASES: THEIR PHYSICS AND TECHNIQUE.—von Engel and Steenbeck. (Book Review in *Hochf:tech. u. Elek:akus.*, December, 1933, Vol. 42, No. 6, p. 220.)

THE ACTION OF [Electrolytic] RECTIFIERS.—W. C. van Geel and H. Emmens. (*Zeitschr. f. Physik*, 1933, Vol. 87, No. 3/4, pp. 220–230.)

This paper describes measurements on electrolytic rectifiers. The barrier layer in the experiments was more than 10^{-6} cm thick. The results may be explained on the assumption that the metal and the electrolyte have different emitting properties. For papers on the same subject *see* Frenkel and Joffé, Abstracts, 1932, p. 290; van Geel, 1931, p. 513; and Nasledow and Nemenow, 1933, p. 402.

Remarks on M. Anastasiadès' Note entitled "On the Mechanism of Rectification in Cupric-Sulphide/Magnesium Rectifiers."—J. Cayrel: Anastasiadès. (*Comptes Rendus*, 3rd Jan., 1934, Vol. 198, No. 1, pp. 64–65.)

See February Abstracts, pp. 106–107. In an "observation" on the present Note, Janet says that the two writers seem to agree as far as experimental results are concerned, but differ in their hypotheses on the respective rôles of cus and cu$_2$s. "It is to be hoped that new researches will elucidate this question."

Investigation of Copper Oxide Films by Electron Diffraction.—C. A. Murison. (*Phil. Mag.*, January, 1934, Series 7, Vol. 17, No. 110, pp. 96–98.)

Rectification and Detection [Mathematical Treatment with Application to "Conversion Detectors."]—Strutt. (*See* under "Properties of Circuits.")

On Balanced D.C. Amplifying Circuits [Three Single-Tube Circuits, the Most Stable being one in which Balance Stability depends on Constancy of μ: a Two-Valve Circuit on this Principle].—L. A. Turner. (*Review Scient. Instr.*, December, 1933, Vol. 4, No. 12, pp. 665–671.)

D.C. Amplifier compensated against Anode Voltage Drop by suitable Ratio of R_i to R_a and Division of Anode Battery into Two Parts, One on Each Side of R_a.—J. F. Tönnies. (German Pat. 581 670, pub. 31.7.1933: *Hochf:tech. u. Elek:akus.*, December, 1933, Vol. 42, No. 6, p. 219.)

A Method for Realising the Full Amplification Factor of High-Mu Tubes [Amplifications of 1 500–2 500 per Stage].—Schmitt. (*See* under "Valves and Thermionics.")

The Use of a Vacuum Tube as a Plate-Feed Impedance [for Single-Stage Amplifier].—Horton. (*See* under "Valves and Thermionics.")

Stabilised Feed-Back Amplifiers.—Black. (*See* under "Acoustics and Audio-frequencies.")

The Reduction of Filament-Battery Coupling in Amplifiers.—Watton: Bainbridge-Bell. (*See* under "Reception.")

The Design and Construction of Electric Wave Filters [for Frequencies up to 50 kc/s].—R. J. Halsey. (*Inst. P.O. Elec. Eng.*, Printed Paper No. 147, 54 pp. and Discussion.)

"Recurrent networks consist broadly of 3 types: ladder networks, lattice or bridge networks, and bridged T networks. . . . . Electric wave filters form a class which can be conveniently developed as ladder networks, and it is in this form that they will now be considered," though on pp. 25–27 it is shown that by using the transformations of Fig. 13 it is possible to obtain equivalent bridge structures for any of the ladder structures already described: these bridge structures will be more wasteful of elements for the same performance except where a differential transformer is employed (giving a "differential bridge filter"). Bridge filter sections are favoured in Germany, "largely in view of patent considerations" (*cf.* Glowatzki, January Abstracts, p. 50, l-h col.). Of the four types of wave filter, the properties of the low-pass and high-pass filters have already been dealt with by Little (February Abstracts, p. 107, r-h col.) and no further theoretical discussion is given in the present paper, which confines itself to band-pass and band-stop filters. The formation of band-pass and -stop filters by means of high- and low-pass sections in series and parallel, respectively, is however discussed on p. 19: see also Appendix B.

In Part II the choice of condensers and inductance is considered, including the use of dust cores of various kinds. The final section deals with the testing of filters. Appendix A gives a study of how intermodulation arises and the magnitude of its products, and the paper ends with a bibliography. In the Discussion Timmis raises the point of the decrease of the effective resistance of a coil, at high frequencies, with a decrease in the resistance of a copper screen: Montgomery prefers "tin" foil to copper foil for condensers, and emphasises the value of impedance-transforming networks and filters in overcoming difficulties in the practical realisation of the inductance and capacity values found by calculation: Stanesby points out that the replacement of band-pass filters by low- and high-pass filters in series is *not* best employed (as suggested) when the passing band is relatively wide; it is very useful when a particularly narrow band is to be passed.

He also discusses the comparative merits of solenoid, slab and wave-wound coils at carrier and radio frequencies. Espley defends the "new" theory of transmission network design (*see* Glowatzki, *loc. cit.*) as more flexible and direct than those due to Campbell and Zobel. The desirable qualities of "D.U." core material, as regards hysteresis and eddy currents, are referred to, but no explanation is given.

Arrangement for the Automatic Calculation of Networks of Impedances: Application to Dipole and Quadripole Electric Filters.—Abélès. (*L'Onde Élec.*, November, 1933, Vol. 12, No. 143, pp. 540–568.) Continuation of the paper dealt with in February Abstracts, p. 107, r-h column.

The Marconi Stabilovolt Current Supply System—Part II.—(*Marconi Review*, Nov./Dec., 1933, No. 45, pp. 12–24.)

Part I was referred to in Jan. Abstracts, p. 51, r-h col. In this final instalment, which includes a section on practical application, it is stated that "practice has taught that battery eliminators equipped with glow-gap dividers show excellent results when supplying power to commercial sets for telegraphy and telephony reception, for picture telegraphy and television equipment, etc. The most complicated receivers which are built for battery operation, and which could not be supplied by the usual battery eliminators, can be operated without difficulty from battery eliminators equipped with glow-gap dividers. In plants in which the breakdown of the supply voltage would cause intense difficulties, a small petrol engine with generator or alternator can be used, thus avoiding the use of storage batteries."

A Simple Method of Stabilising the Voltage of a D.C. Generator [Compensation of Temperature Effect on Windings by means of Iron-Wire Ballast Resistance in Exciting Circuit].—E. Santuari. (*Rev. Gén. de l'Élec.*, 6th Jan., 1934, Vol. 35, No. 1, pp. 33–34.)

A Regulating Choking Coil with Potential Control [for Voltage Stabilisation].—G. Stein. (*Bull. de l'Assoc. suisse des Élec.*, 8th Dec., 1933, Vol. 24, No. 25, pp. 658–662 : in German.)

Voltage Regulation of Alternators with the aid of Thermionic Valves [and Glow-Discharge Potential Dividers].—W. Druey. (*Bull. de l'Assoc. suisse des Élec.*, 8th Dec., 1933, Vol. 24, No. 25, pp. 647–650.) In French. *See* also Jan. Abstracts, p. 52, l-h column.

Stabilisation of the Frequency *n* of the Alternating Current of a Supply Network [Synchronisation of the Generators of the Various Sections].—A. Guillet. (*Comptes Rendus*, 27th Nov., 1933, Vol. 197, No. 22, pp. 1307–1309.)

A Generator for Low Frequencies [Self-Exciting Commutator-Type Alternator of Frequency 2.5 Cycles/Second].—J. I. Hull. (*Elec. Engineering*, September, 1933, Vol. 52, No. 9, pp. 631–636.)

Special Number devoted to Electric Motors.—(*E.T.Z.*, 12th Oct., 1933, Vol. 54, No. 41, pp. 977–1012.)

Improvements in the Balancing of Rotating Parts [Turbo-Alternator Rotors, Television Discs, etc. : using a Capacity-Variation Device as Indicator].—Ferranti Company. (French Pat. 750 629, pub. 14.8.33 : *Rev. Gén. de l'Élec.*, 30th Dec., 1933, Vol. 34, No. 26, p. 205 D.)

High-Frequency Transformer [covering Whole Broadcast Frequency Range : suitable (e.g) for Matching a Transmitting Valve with a Wave Filter or Low-Resistance Load : Band-Filter Circuit, using Compressed Iron Core].—A. Jaumann and F. Troeltsch. (*Veröffentlichungen aus dem Gebiete der Nachrichtentechnik*, No. 1, 3rd year, 1933, pp. 57–59.)

Dust-Core Tuning Coils.—N. W. McLachlan. (*World-Radio*, 22nd Dec., 1933, and 5th Jan., 1934, Nos. 439 and 441, pp. 843 and 20 : to be continued.)

A New High-Frequency Calorimeter for the Investigation of Dielectric Losses in Liquids.—L. Pungs and H. Rieche. (*Zeitschr. f. tech. Phys.*, No. 11, Vol. 14, 1933, pp. 483–485.)

Dipole Moment and Solvent [and a Precise Method of Measuring the Dielectric Constants of Liquids].—H. Müller. (*Physik. Zeitschr.*, 15th Sept., 1933, Vol. 34, No. 18, pp. 689–710.)

Power Loss Phenomena in Liquid Dielectrics.—W. Jackson. (*Proc. Roy. Soc.*, November, 1933, Vol. 142, No. A 847, pp. 606–620.)

"The paper covers a series of dielectric loss measurements on samples of several liquid hydrocarbon derivatives—benzene, toluene, chlorbenzene and nitro-benzene—over the frequency range 2×10^5 to 2×10^6 cycles per second, before and after the application of steady voltage."

Conductivity and Dielectric Constant of Liquids in High-Frequency Fields.—M. Wien. (*Physik. Zeitschr.*, 15th Aug., 1933, Vol. 34, No. 16, pp. 625–627.)

The Temperature Variation of the Dispersion of the Conductivity [of Electrolytes].—H. Geest. (*Physik. Zeitschr.*, 1st Sept., 1933, Vol. 34, No. 17, pp. 660–671.)

Measurements of the Conductivity of Some Weak Electrolytes and Glycerine Solutions with 75 cm Waves.—B. G. Whitmore. (*Physik. Zeitschr.*, 1st Sept., 1933, Vol. 34, No. 17, pp. 649–659.)

Measurement of the Conductivity and Dielectric Constant of Electrolytes down to Wavelengths of 1 Metre.—P. Wenk. (*Ann. der Physik*, 1933, Series 5, Vol. 17, No. 6, p. 679–698.)

Frequency-Shifting ["Detonierende"] Repeaters [Prevention of Singing in Two-Way Repeaters, by a Slight Frequency Change in One Path].—H. Decker. (*E.N.T.*, October, 1933, Vol. 10, No. 10, pp. 416–422.)

Automatic Chart Analyser.—E. A. Speight and H. J. Josephs. (*P.O. Elec. Eng. Journ.*, January, 1934, Vol. 26, Part 4, pp. 275–277.)

On a Method of Applying Electric Fields for Short Intervals of Time [10^{-4} Second : Mechanical Device with a "Tearing Contact" for Several Hundred Volts].—Nasledov, Nemenov and Reinov. (*Journ. Scient. Instr.*, September, 1933, Vol. 10, No. 9, pp. 288–291.)

Temperature and Brightness Variations of Incandescent Lamps with Periodically Varying Voltage.—G. Nidetzky. (*Zeitschr. f. tech. Phys.*, No. 8, Vol. 14, 1933, pp. 308–312.)

Measurement of Spark Brightness and Duration [in connection with the Photography and Kinematography of Very Rapid Processes].—Kornetzki, Fomin and Steinitz. (*Zeitschr. f. tech. Phys.*, No. 7, Vol. 14, 1933, pp. 274–280.)

For Cranz and Schardin's paper on the use of sparks in this connection *see* 1929 Abstracts, p. 648, r-h column.

Recent Advances in Sensitisers for the Photography of the Infrared.—L. G. S. Brooker, F. M. Hamer and C. E. K. Mees. (*Journ. Opt. Soc. Am.*, June, 1933, Vol. 23, No. 6, pp. 216–222.)

A Flexible and Non-Extensible Driving Band [Parallel-Strand " Rope " of Sewing Cotton]. —J. M. Waldram. (*Journ. Scient. Instr.*, December, 1933, Vol. 10. No. 12, p. 395.)

A Satisfactory Solder for Aluminium.—A. G. C. Gwyer. (*Journ. Scient. Instr.*, December, 1933, Vol. 10, No. 12, pp. 396–397.)

STATIONS, DESIGN AND OPERATION

Improved Radio Service with Aircraft by Simultaneous Transmission on 31 m and 900 m Waves [Holland/Dutch-East-Indies Service].—(*T.F.T.*, December, 1933, Vol. 22, No. 12, p. 322 : summary only.)

Paired Broadcasts [Experiments in Holland on the Transmission of Two Programmes over a Single Carrier Wave, by Rotating Distributor at Transmitter and Synchronised Oscillator at Receiver, putting Two Input Valves alternately into Operation].—(*Rad. Engineering*, December, 1933, Vol. 13, No. 12, p. 23.)

The German Broadcasting Line Network [Design of Lines and Amplifiers : Line Distortion : Measuring and Monitoring Apparatus : etc.].—P. Sprinck. (*E.T.Z.*, 18th Jan., 1934, Vol. 55, No. 3, pp. 61–64.)

Die Entzerrung der Rundfunkfernleitungen (Distortion Correction of Long-Distance Lines for Broadcasting).—L. Fenyö. (*T.F.T.*, November, 1933, Vol. 22, No. 11, pp. 275–277.)

Common-Wave Broadcasting with Completely Synchronised Transmitter Frequencies departing only slightly from the Common Value.—F. Vilbig. (*T.F.T.*, December, 1933, Vol. 22, No. 12, pp. 314–321.)

Author's summary :—The interference zone of two common-wave transmitters with completely constant equality of frequency is calculated, and also determined by [water-wave] model tests. It is found that over-control of the carrier frequencies and distortions due to side-frequency extinctions are to be expected in the interference zone. As one station is approached these effects become smaller. When the interference " wanders " owing to incomplete synchronism of the transmitter frequencies, the same troubles occur at first as in the case of complete agreement between the frequencies ; the chief disturbing effect, however, is fluctuation of signal strength. If the beat period is sufficiently long, a further bringing-together of the frequencies (*e.g.*, to within 1/100 c/s) improves matters only if the distortions occuring even at complete equality are diminished by phase equalisation by means of the modulating frequencies [by regulating the phase of these latter].

If the distances between the stations are comparatively small, an increased number of stations diminishes the undisturbed zone. But if two stations on one common wave are arranged crosswise to another pair on a second common wave, the region of good reception is enlarged.

The U.I.R. Conference in Amsterdam, October, 1933.—(*Rev. Gén. de. l'Élec.*, 20th Jan., 1934, Vol. 35, No. 3, pp. 101–102 : summary only.)

Do Transmitting Stations Get Tired ? [Assertion that Land Stations lose Power after a Few Weeks or Months : Suggested Deterioration of Earths].—A. Dinsdale. (*Wireless Engineer*, January, 1934, Vol. 11, No. 124, p. 24.) For Editorial *see* p. 2.

The France/Algeria Radiotelephonic Service [Short-Wave Beam].—R. Rigal. (*Ann. des P.T.T.*, December, 1933, Vol. 22, No. 12, pp. 1041–1081.)

Ultra-Short-Wave Service between Monte Rosa and Col d'Olen [Telephony on a 5-Metre Wave : Distance 6.3 km : Total Power 7 Watts, from Dry Cells].—(*Alta Frequenza*, October, 1933, Vol. 2, No. 4, pp. 614–615.)

Police Radio Service [" Information of Value to Municipalities operating Police Radio Systems, and Those contemplating Such Service "].—(*Rad. Engineering*, December, 1933, Vol. 13, No. 12, pp. 16–18.)

Police Radio to Higher Frequencies [Allocations in the 9-Metre Band].—(*Ibid.*, p. 26: paragraph only.)

The Amateur and Police Radio.—R. S. Kruse. (*QST*, January, 1934, Vol. 18, No. 1, pp. 34–37 and 65.)

New Developments in German Telegraphy Technique [including the Siemens-Hell System using Facsimile Transmission of Roman Capitals].—H. Stahl. (*E.T.Z.*, 4th Jan., 1934, Vol. 55, No. 1, pp. 13–14.)

The Siemens-Hell Recorder.—H. Stahl. (*T.F.T.*, November, 1933, Vol. 22, No. 11, pp. 291–295.)

On the Calculation of Telegraphy Speed.—H. Salinger and H. Stahl. (*E.N.T.*, December, 1933, Vol. 10, No. 12, pp. 466–472.)

GENERAL PHYSICAL ARTICLES

Note on the Paper " On Models of the Electric Field and of the Photon " [Possibility of Production of Matter from Ether by Very Intense Electric Fields].—J. J. Thomson. (*Phil. Mag.*, January, 1934, Series 7, Vol. 17, No. 110, pp. 197–198.) *See* February Abstracts, p. 109.

Materialisation of the Ether [Experimental Confirmation ?].—V. Posejpal. (*Comptes Rendus*, 3rd Jan., 1934, Vol. 198, No. 1, pp. 59–62.)

On the Nature of the Photon.—L. de Broglie. (*Comptes Rendus*, 8th January, 1934, Vol. 198, No. 2, pp. 135–138.)

Remarkable Optical Properties of the Alkali Metals.—Zener. (*See* under " Propagation of Waves.")

On the Solutions of the Maxwellian Equations for Space [establishing a Connection between the Electromagnetic Theory and the Quantum Theory of Photons].—Al. Proca. (*Comptes Rendus*, 26th Dec., 1933, Vol. 197, No. 26, pp. 1725–1727.)

Electromagnetic Mass, *and* Foundations of the New Field Theory.—M. Born and L. Infeld. (*Nature*, 23rd and 30th Dec., 1933, Vol. 132, pp. 970 and 1004.)

The modification of Maxwell's field equations proposed by the writers makes it possible to revive the old idea of the electromagnetic origin of inertia. " The Lorentz equations for the motion of an electron in an external field are approximately true, and the energy is given by mc^2."

A Unified Field Theory.—I. Electromagnetic Field [Representation of Unified Field of Two Particles by Eight-Dimensional Space, Whose Metric satisfies Einstein's Law of Gravitation].—D. Meksyn. (*Phil. Mag.*, January, 1934, Series 7, Vol. 17, No. 110, pp. 99–112.)

MISCELLANEOUS

A New Method of Calculating Circuits [" Short-Circuit Current Solution," applicable to D.C. and A.C. (including High Frequency) Circuits].—W. B. Kouwenhoven and M. W. Pullen. (*Elec. Engineering*, November, 1933, Vol. 52, No. 11, pp. 776–779.) For a criticism, referring to the well-known Thevenin's theorem, see *ibid.*, December, p. 936, and for further remarks, January, 1934, p. 228.

Graphic Statistics [Plotting of Frequency-Distributions].—A. F. Dufton. (*Proc. Phys. Soc.*, 1st Jan., 1934, Vol. 46, Pt. I, No. 252, pp. 47–50.)

Carrier Current Transmissions along High-Tension Lines [and an Inductive Wave-Trap Patent].—J. Bethenod : Garczynski. (*L'Onde Élec.*, November, 1933, Vol. 12, No. 143, p. 539.) Reference to a 1914 patent covering a circuit mentioned in Garczynski's paper (February Abstracts, p. 110, l-h column.)

High-Frequency [Carrier-Current] Telephony on Lines, with Short Carrier Waves [5 000 m to 40 m : Application to Television Transmission on Overhead Lines].—Kirschstein and Laub. (*See* under " Phototelegraphy and Television.")

Water Wave Telephony—Transmission of the Voice by Mechanical Oscillations [Modulated Supersonic Waves of 40 000 c/s Frequency : 4 miles Range on 25 Watts].—M. Marro. (*Electrician*, 17th Nov., 1933, Vol. 111, No. 2894, p. 609.)

Communication for Freight Trains.—G.E.C. (*Scient. American*, December, 1933, Vol. 149, No. 6, p. 284.)

The " Vistaphone."—A. C. Oranges. (*Electrician*, 8th Dec., 1933, Vol. 111, No. 2897, p. 729.)

A multi-purpose cabinet instrument which acts as a " home cine projector, a gramophone, a radio receiver, a public address system, a recorder of personal performance or radio programmes, and a cine camera."

The Use of the Motion Camera for Testing Electrical Apparatus.—W. Wilson. (*G.E.C. Journ.*, November, 1933, Vol. 4, pp. 236–240.)

Observations on the Terminology in New Discoveries [Certain Barbarisms, and the Need for an International Commission].—A. Blondel. (*Comptes Rendus*, 18th Dec., 1933, Vol. 197, No. 25, pp. 1555–1556.) *See* also *Rev. Gén. de l'Élec.*, 20th Jan., 1934, Vol. 35, No. 3, pp. 73-75, for Editorial comments.

Progress in Electrical Communication [Historical Outline].—E. V. Appleton. (*Nature*, 2nd Dec., 1933, Vol. 132, pp. 843–845.)

Recent Advances in the Radio Art [and Present Defects].—Ballantine, Goldsmith and others. (*Electronics*, December, 1933, pp. 328–331.)

Developments in Radio Engineering at the 10th Radio Exhibition, Paris, 1933.—M. Adam. (*Rev. Gén. de l'Élec.*, 4th Nov., 1933, Vol. 34, No. 18, pp. 609–614.)

The Berlin Jubilee Radio Exhibition.—F. Fuchs. (*Hochf:tech. u. Elek:akus.*, December, 1933, Vol. 42, No. 6, pp. 208–212.)

The Fifth National Radio Exhibition, Milan, 1933.—G. Fassio. (*La Ricerca Scientifica*, 15th November, 1933, 4th Year, Vol. 2, No. 9, pp. 331–336.)

Physical Society's Exhibition.—(*Electrician*, 12th Jan., 1934, Vol. 112, No. 2, pp. 39–43.)

Wireless at the Physical Society's Exhibition.—(*Wireless World*, 19th January, 1934, Vol. 34, pp. 47–48.)

International Physical Chemistry Reunion, Paris, 1933 [including Summaries of Papers on Semi-Conductors, etc.].—A. H. Wilson, A. F. Joffé and others. (*Rev. Gén. de l'Élec.*, 23rd Dec., 1933, Vol. 34, No. 25, pp. 851–859.)

Improved Photoelectric Colour-Selecting Equipment [*e.g.* for Brocade Weaving Looms].—Nakanishi and Kinsaku. (French Pat. 753 979, pub. 28.10.1933 : *Rev. Gén. de l'Élec.*, 30th Dec., 1933, Vol. 34, No. 26, p. 207 D.)

Photoelectric Equipment for the Continuous Examination of Cold-Rolled Metal Strip for Holes and Tears.—E. Bornitz. (*Zeitschr. V.D.I.*, 16th Dec., 1933, Vol. 77, No. 50, p. 1339.)

The Photoelectric Cell applied to Commercial Control Purposes [Book Review].—Geffcken, Richter and Winckelmann. (*Hochf:tech. u. Elek:akus.*, December, 1933, Vol. 42, No. 6, p. 220.)

Photoelectric Cell Applications [Book Review].—R. C. Walker and T. M. C. Lance. (*Wireless Engineer*, January, 1934, Vol. 11, No. 124, p. 11.)

Recent Applications of Photoelectric Cells [Photoelectric Organ, Visagraph, in Printing and Paper Industries, etc.]—R. C. Walker. (*World Power*, January, 1934, Vol. 21, No. 121, pp. 14–19.)

Guard-Ray Equipment covering Large Area with Single Light Source and Single Photocell.—Soc. Gén. de Constructions Elec. et Mech. (French Pat. 753 867, pub. 26.10.33: *Rev. Gén. de l'Élec.*, 30th Dec., 1933, Vol. 34, No. 26, p. 206 d.)

Radiometric Condensers and Inductances [and a Possible Use for Guard-Ray Purposes].—Blake. (*See* abstract under "Measurements and Standards.")

The "Capacity Cell" [Sensitive to the Approach of a Body: Small Mains-Driven Glow-Discharge Tube with External Adjustable Electrode: Possible Application as Aircraft Height Indicator].—J. Michel. (*Funk-Magazin*, August, 1933, Vol. 6, No. 8, pp. 499–502.)

Filamentless Tubes for Elevator Control.—Hund. (*Electronics*, November, 1933, p. 307.)

Vacuum-Tube Device for testing Welds.—Batcheller. (*Electronics*, November, 1933, p. 306.)

Speeches in Conference Hall of League of Nations broadcast to Perambulating Listeners wearing Headphones connected to Pocket Crystal Receivers.—(*World-Radio*, 10th Nov., 1933, Vol. 17, No. 433, p. 616.)

The Electrical Indication and Registration of Torques [by Capacity-Change Methods].—E. Rolf. (*E.T.Z.*, 30th Nov., 1933, Vol. 54, No. 48, pp. 1160–1163.)

The Magneto-Elastic Measurement of Forces of Pressure, Tension and Torsion.—W. Janovsky. (*Zeitschr. f. tech. Phys.*, No. 11, Vol. 14, 1933, pp. 466–472.)

Investigations on Rubber-Damped Railway Wheels with the Reutlinger [Electromagnetic] Universal Vibration Meter.—(*Zeitschr. V.D.I.*, 2nd Sept., 1933, Vol. 77, No. 35, pp. 955–958.)

The Use of the Condenser as a Measuring Instrument [Gerdien Condenser, Idometer, and Siccometer].—(*Bull. de l'Assoc. suisse des Élec.*, 22nd Dec., 1933, Vol. 24, No. 26, pp. 679–680.)

Electronic Speed Regulator in the Manufacture of Paper.—D. F. Cronin and C. W. Drake. (*Elec. World*, 21st October, 1933, Vol. 102, pp. 538–540.)

Detection of Larvae in Wood, Weevils in Grain and Fruit, etc., by Microphone-Amplifier-Loudspeaker Combination.—C. K. Brain. (*Review of Applied Entomology*, Vol. 13, 1925, p. 77.)

Messung der Erwärmung von Flüssigkeiten im hochfrequenten Kondensatorfeld (Measurement of the Heating of Liquids in the [Ultra-] High-Frequency Condenser Field: Preliminary Communication).—N. N. Malov. (*Hoch:tech. u. Elek:akus.*, December, 1933, Vol. 42, No. 6, pp. 190–194.)

The wavelengths used were 5.15 and 3.70 metres. A large number of liquids were tested, including milk, various oils, and some aqueous solutions of salts, etc. The effect of particle size was examined by using emulsions of oil in water with different proportions of oil, thus varying the size of the oil particles. Glass, wood, brass and carbon, in solid form, were compared as regards heating with the same materials in the form of particles suspended in water: the heating was greater in the latter case, particularly with carbon, where the ratio was 3.87 : 1.

Pätzold's formula for electrolytes (Abstracts, 1932, p. 541, l-h col.) relating conductivity, dielectric constant and frequency by $\sigma = \epsilon f/2$, was confirmed. Pflomm's conclusion as to the additive effect of the heating of the various components in a complex physiological solution, such as Ringer's solution, was contradicted. It was also shown that the heating of non-conducting aqueous solutions (of sugar and gelatine) increases with increasing viscosity (Figs. 10 and 11): "this influence of viscosity is of great interest."

The Effect of Electric Waves on Colloids [105 m–260 m Waves Locally Generated, and Distant Broadcast Waves: Changes in Colour, Viscosity, Kataphoresis, etc.].—E. Wilke and R. Müller. (*Kolloid-Zeitschr.*, December, 1933, Vol. 65, No. 3, pp. 257–260.)

Some Further Remarks on the Use of the Magneto-Optic Method [for Investigation of Distribution of Injected Materials in Blood, Various Organs, etc.]—H. D. Jones and R. Goslin. (*Journ. Amer. Chem. Soc.*, No. 8, Vol. 55, 1933, pp. 3500–3501.)

The Mitogenetic Radiations of Blood [Correspondence].—G. Protti: U. Ferri. (*La Ricerca Scientifica*, October, 1933, 4th Year, Vol. 2, No. 7/8, pp. 266–267.)

Some Recent Patents

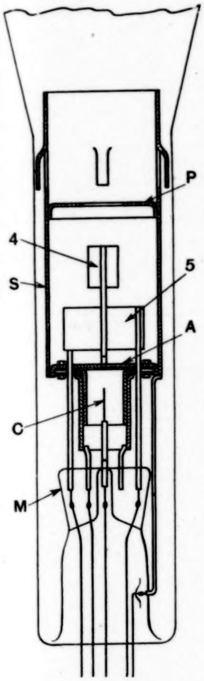
The following abstracts are prepared, with the permission of the Controller of H.M. Stationery Office, from Specifications obtainable at the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1/- each.

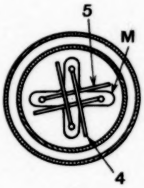
CATHODE-RAY TUBES

Application date, 29th January, 1932. *No.* 396422

The hot cathode *C* is mounted in a focusing-screen below the "gun" anode *A*, whilst a positively biased screening-cylinder *S* is mounted above, in order to protect the control electrodes 4, 5 from the effect either of secondary emission from the fluorescent screen, or from electrostatic charges on the walls of the glass bulb. A lateral partition *P* serves as a further safeguard. The whole of the electrode assembly is mounted on a star-shaped "pinch" *M*, shown separately in Fig. 1 (*a*) together with the rectangularly arranged deflecting or scanning electrodes 4, 5.

Patent issued to W. R. Bullimore and L. H. Bedford.





1(a)

No. 396422.

FILM TELEVISION SYSTEMS

Convention date (Germany), 20th February, 1932. *No.* 395985

Relates to television transmitters of the type in which the fluorescent light from a cathode-ray tube is caused to scan a photographic film laterally, whilst the film is simultaneously given a vertical downward movement in order to complete the scanning operation. The horizontal traverse of the beam is effected by means of a pair of control electrodes, whilst a lens is used to focus the fluorescent spot on to the film. In such a system it is found that the movement of the cathode ray over the fluorescent screen always follows the same track, and that this in course of time tends to impoverish the fluorescent response of the screen. According to the invention suitable means are provided, known *per se*, for shifting the line of impact of the ray from time to time so that it makes a fresh parallel track over the fluorescent surface.

Patent issued to Telefunken ges für Drahtlose Telegraphie M.B.H.

TELEVISION SYSTEMS

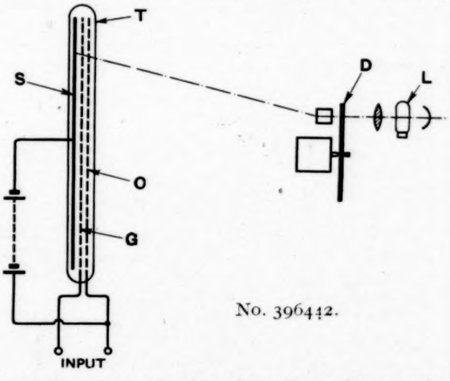
Convention date (Germany), 24th October, 1931. *No.* 396580

In a system utilising contant-intensity control of the cathode-ray, the varying light-and-shade values of the picture being dependent upon the transverse speed of the scanning spot, distortion is prevented by using a scanning-control voltage which is not of constant steepness, but varies with the mean value of the light-intensity of each line. Separate oscillation generators are used for producing the image and line "control" potentials. These are coupled together through a common "mixing" resistance, from which a tapping is taken to the first of the amplifiers supplying the scanning-voltages to the tube.

Patent issued to M. von Ardenne.

Application date, 4th February, 1932. *No.* 396442

The viewing-screen *S* is coated with photo-sensitive material and mounted in a substantially planar gas-filled tube *T* in association with a cathode *C* and control electrode *G*. The screen *S* is scanned by an intense source of light *L* through a Nipkow disc *D*, and simultaneously the incoming signal voltages are applied to the terminals across the control electrode *G* and cathode *C*. The signal voltages "trigger" individual glow-discharges, which reproduce the transmitted picture on the screen *S*. The photo-sensitive layer on the screen responds only to the blue light from the scanning lamp *L*, being insensitive to the orange-coloured light of the glow-discharge inside the tube *T*.



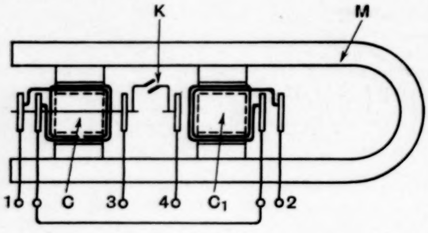
No. 396442.

Patent issued to Marconi's Wireless Telegraph Co., Ltd., and R. Cadzow.

"CALLING" RELAYS

Application date, 10th February, 1932. No. 396753

Two moving coils *C*, C1 are mounted to rotate in opposite directions about the same axis in the field of the magnet *M*, and are connected in series across terminals 1, 2 in the plate circuit of the last valve in a wireless receiver tuned to the calling frequency. Both coils have the same moment of inertia, *i.e.*, they are subjected to equal restoring couples so that the contact *K* is not closed by extraneous mechanical vibration. The receipt of a calling signal closes the contact *K* and so actuates a local buzzer or alarm-bell circuit branched across the terminals 3, 4.



No. 396753.

Patent issued to C. L. P. Dean and C. W. H. Begbie.

VOLUME-CONTROL SYSTEMS

Convention date (U.S.A.), 27th January, 1931.
No. 396046

In order to improve the signal-to-noise ratio, say along a telephone line, or in wireless transmission, or in recording sounds on films or discs, the level of energy or volume is compressed at the input end of the system and is expanded again at the distant or receiving end. Both operations are effected by means of thermionic valves inserted in shunt across the line. The effective impedance of the shunt is varied inversely as the square root of the applied signal voltage for compression. In expansion the control circuit includes a rectifier, having a linear input-output characteristic, and a suitable filter. The specification contains a mathematical analysis of the circuit arrangements.

Patent issued to Electrical Research Products Inc.

SUPERHET RECEIVERS

Application date, 11th February, 1932. No. 396772

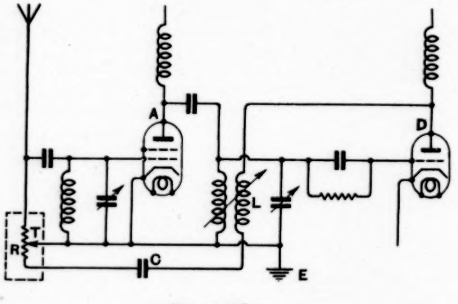
In order to combine good reproduction with high selectivity a ganged variometer-and-condenser band-pass input is combined with a band-pass coupling between the first detector and the intermediate-frequency amplifier. From the output of the I.F. amplifier a portion of the intermediate carrier frequency is filtered off, subjected to independent amplification, and then re-injected into the circuit of the second detector valve. High selectivity is ensured by the demodulating effect of the amplified I.F. currents on any weak interfering carrier-frequencies that may be present in the main signal channel, whilst the output level of the desired signals is correspondingly increased. A tone-correcting network is used to prevent undue emphasis of the lower frequencies and also to cut out heterodyne " whistle."

Patent issued to Standard Telephones & Cables, Ltd., and R. M. Barnard.

VOLUME CONTROL

Application date 18th February, 1932. No. 396822

Relates to combined volume and reaction control arrangements of the kind shown in the drawing, in which a variable tapping *T* on the resistance *R* simultaneously increases or decreases both the aerial input to the first valve *A* and the amount of feed-back through the coil *L* and condenser *C* from the detector valve *D*. The invention consists in " grading " the resistance *R* so that it has a range of low values at the end nearest the aerial, whereby as the circuit tends to self-oscillation the shunt on the aerial becomes sufficiently large to exercise a definite damping action on the tuned input to the H.F. valve.



No. 396822.

Patent issued to The General Electric Co., Ltd., and D. H. Hughes.

MULTI-VIBRATOR CIRCUITS

Convention date (Germany), 29th December, 1931.
No. 397007

An oscillation-generator of the multi-vibrator type, comprising a pair of resistance-capacity coupled valves with the anode and grid circuits reciprocally back-coupled, is characterised by the insertion of a piezo-electric crystal in the connection from the anode of one valve to the grid of the next, in order to stabilise the working frequency. For short-wave working a capacity coupling is used between the anode of the second valve and the grid of the first (so as to allow the use of a common source of H.T.), a tunable oscillatory circuit being substituted for the coupling resistance in the anode circuit of the second valve.

Patent issued to Telefunken Ges. für drahtlose Telegraphie M.B.H.

TUNING INDICATORS

Convention date (Germany), 8th December, 1931.
No. 396983

The dial-markings, in wavelengths, degrees, or stations, are printed in small characters on a transparent celluloid disc, preferably mounted at the rear end of the control spindle, and a magnified image is reflected from a rear lamp and lens-system on to a viewing-screen inserted in the front panel of the set ; or it may be focussed on the face of the loud speaker.

Patent issued to Ideal Werke akt. für drahtlose Telephonie.

LOUD SPEAKERS

Application date, 6th December, 1932. *No.* 396990

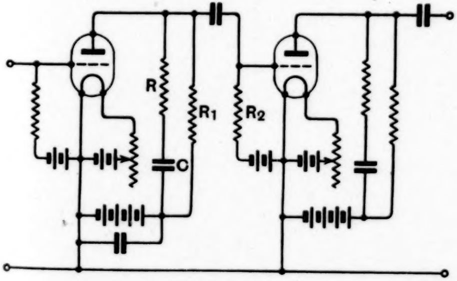
A vibrating-reed type of speaker-movement is characterised by the use of an L-shaped magnet, one end of the reed being clamped to the shorter limb, whilst the other end extends above a pole-piece mounted on the longer limb of the magnet. A triangular piece is stamped out of the reed, near its fixed end, so as to allow a longer reed to be used without loss of resiliency.

Patent issued to J. H. W. Lewis.

THERMIONIC AMPLIFIERS

Convention date (U.S.A.), 28th April, 1932.
No. 397076

In television and amplifiers where the range of frequencies to be handled may vary from 20–200,000 cycles or more, the ordinary resistance-capacity type of coupling is found to introduce a large phase-drift at the lower frequencies. This causes the various lines of the image to shift and so gives rise to distortion. According to the invention, a condenser C is inserted in series with a resistance R in shunt across the anode coupling-resistance R_1, and the values of C and R are so proportioned that the signal component across the condenser is just sufficient to cause the " lag " in volts across the resistance R_1 to offset the " lead " across the grid-coupling resistance R_2. A vectorial analysis of the circuit conditions is given in the specification.



No. 397076.

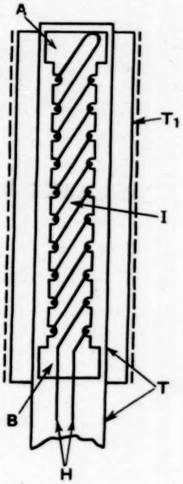
Patent issued to British Thomson-Houston Co., Ltd.

INDIRECTLY-HEATED VALVES

Convention date (Germany), 26th November, 1931.
No. 397350

Relates to means for preventing (*a*) microphonic " noise " due to the fact that the heater is not firmly embedded in the insulator mass, and (*b*) the transfer of " hum " from A.C. mains owing to inadequate insulation between the heater and cathode. As shown in the drawing, the ceramic insulator I is formed with helical grooves to take a " bifilar " heating wire H, and with enlarged ends A, B. A metallic screening tube T, which may be earthed, is drawn over the enlarged ends A, B, and is surrounded in turn by a second tube T_1 forming the emitter. The arrangement ensures that the outer tube T_1 is supported by the inner tube only at relatively-cool points, whilst there is a vacuum insulation between the strongly-heated parts. To increase the heat radiation from the tube T, its outer surface is roughened and coated with a black deposit of powdered tungsten or zirconium.

Patent issued to Telefunken Ges. fur drahtlose Telegraphie M.B.H.



No. 397350.

TUNING INDICATORS

Convention date (U.S.A.), 2nd April, 1932.
No. 397067

The dial markings are printed in a colour other than black on a disc illuminated by a lamp, and a relatively-movable masking-element of translucent material is mounted between the disc and the viewing point. The major part of the mask is of the same colour as the scale marking, whilst a smaller central " window " portion is of a complementary colour. The result is that light reflected from or transmitted through the dial markings is modified by the masking means before it reaches the eye of the observer, so that the appropriate marking alone " floats " into view at the central window, the remainder of the dial remaining practically invisible at all times.

Patent issued to Marconi's Wireless Telegraph Co., Ltd.

" ANTI-STATIC " DEVICES

Convention date (Germany), 12th October, 1931.
No. 397320

To prevent undesirable radiation from the brushes of series-wound motors used in domestic labour-saving devices, one or more unearthed condensers are shunted across the supply leads to the exciting-windings, and two or more condensers are connected in series across the brushes, the mid-point of the latter pair of condensers being earthed to the framework of the appliance.

Patent issued to Electrolux, Ltd.

SHORT-WAVE GENERATORS

Application date, 27th February, 1932. *No.* 397555

In a valve oscillator of the Barkhausen-Kurz type, it is known that alteration of the grid potential affects the generated frequency. When the main oscillatory circuit is connected across the grid and anode, the current from the cathode goes partly to the grid (which tends to damp the oscillations) and partly to the anode, where regeneration occurs. According to the invention the undesirable damping effect is avoided by arranging the valve electrodes, and the external tuned Lecher-wire circuit, in such manner that the grid of the valve is located substantially at a potential node in the main oscillatory circuit.

Patent issued to Marconi's Wireless Telegraph Co., Ltd., and E. W. B. Gill.

TWO-WAY SIGNALLING SYSTEMS

Convention date (Germany), 16th May, 1931. *No.* 397620

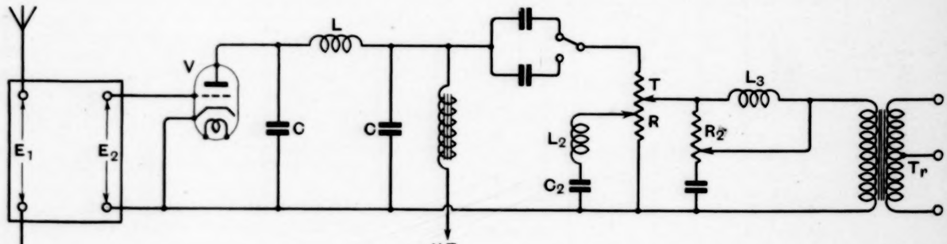
In order to prevent the transmitter in a two-way system from affecting the receiver at the same station, the outgoing carrier-wave is polarised in one plane whilst the incoming carrier is oppositely polarised. The receiving aerials at each station are so aligned, horizontally or vertically, that they are affected only by the incoming and not by the outgoing waves. It is stated that both incoming and outgoing carriers may have the same wavelength.

Patent issued to Pintsch Akt and Dr. K. Kohl.

TONE AND VOLUME CONTROL

Convention dates (U.S.A.), 30th January and 21st October, 1932. *No.* 397763

In a receiver fitted with automatic volume control, specific provision is made for controlling the audio-frequency response in such a manner as to compensate for the natural tendency of the human ear to over-emphasise the middle range of frequencies as compared with the upper and lower notes. As shown in the figure any known system of A.V.C. is applied between the aerial $E1$ and the input $E2$ to the detector valve V. The output circuit of that valve comprises a bandpass filter L, C and a potentiometer tone-control R. The latter is shunted at the low-potential end by a series choke $L2$ and a condenser $C2$, whilst a variable tapping T at the high-potential end brings in a second control comprising a resistance $R2$ and a parallel choke $L3$. The whole control network is in shunt across the primary of the output transformer Tr.



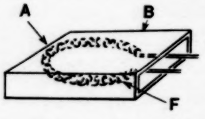
No. 397763.

Patent issued to Marconi's Wireless Telegraph Co., Ltd.

INDIRECTLY-HEATED CATHODES

Convention date (Germany), 7th March, 1931. *No.* 397939

To reduce undesirable effects due to fluctuating magnetic fields associated with the heating current, particularly in the case of a cathode-ray tube, the tungsten filament F is wound as a toroid and is inserted inside the open end of a small metal box B which forms the cathode. The closed narrow end A of the box is coated externally with an emissive substance, whilst the internal surface is lined with insulating material.



No. 397939.

Patent issued to International General Electric Co., Inc.

LOUD SPEAKER INSTALLATIONS

Convention date (Switzerland), 5th March, 1931. *No.* 397214

In public-address and similar systems the so-called acoustic back-coupling (due to the effect of "room" and "echo" vibrations), tends to produce an undesirable muffling or masking of the original sounds. To overcome this effect a second microphone is located at a point sufficiently remote from the main microphone to be unaffected by the primary sounds. Room or echo vibrations, however, affect both microphones equally, but since each microphone is coupled through a separate but oppositely-wound primary winding to the common secondary winding of the transformer feeding the amplifier, all undesired acoustic interactions are automatically balanced out, and the original speech-frequencies are alone amplified.

Patent issued to H. Guggenheim.